THE MODEL ENGINEER

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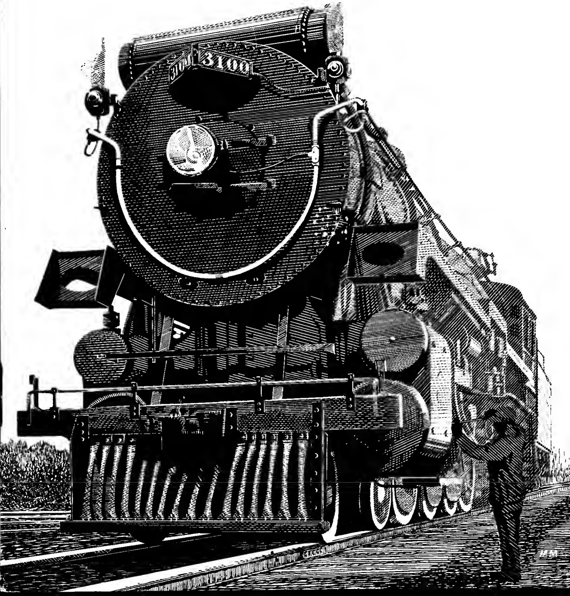


The MODEL ENGINEER

Percival Marshall & Co. Ltd., 23, Great Queen St., London, W.C.2

17 APRIL 1947

VOL. 96. NO. 2395

SMOKE RINGS

Our Cover Picture

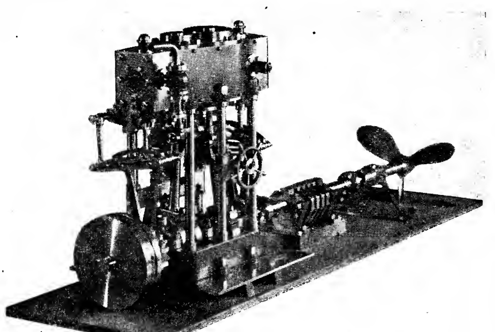
THE drawing which our artist has submitted for the cover of this week's issue was made from a striking photograph of the Canadian National Railways' splendid express passenger locomotive, No. 3100. The photograph was sent to us by Mr. John E. Wood, of New Westminster, British Columbia. No. 3100 is one of a class of 4-8-4 type engines built for working some of the principal long-distance express trains in the Dominion. They have cylinders 23 in. diameter by 30-in. stroke; driving-wheels 6 ft. 4 in. diameter; boiler pressure 250 lb. per sq. in., and a nominal tractive force of 60,000 lb. The tender is mounted on two 6-wheeled bogies.

The "M.E." and the Paper Shortage

THIS week we are putting to the test the old saying that a trouble shared is a trouble halved, by unburdening ourselves to our readers who, by their loyal support through the years and their constant encouragement, have shown themselves to be our best friends. As everyone knows, the National coal shortage has necessitated drastic cuts in the allocation of fuel to paper mills, with the result that THE MODEL ENGINEER, in common with all other British journals, has for some time past, experienced extreme difficulty in obtaining adequate supplies of paper to maintain publication in its present form. We are, in fact, now faced with the alternative of either reducing the number of copies available to our readers, or, from time to time, making a small reduction in the number of pages. We are sure that to deprive a considerable number of our readers of their weekly copy of THE MODEL ENGINEER would be the cause of much disappointment, and the question of who should go without is so impossible to answer with fairness, that we have decided that a slight reduction in size is the lesser of the two evils. It is hoped that any reduction which may have to be made will be for a limited period only, and we shall continue to provide, within the covers, as much of our regular features and other worthwhile material as we possibly can. We are confident that our friends will bear with us in our difficulties, as we feel sure that many of them, being engaged in other fields of production, will be faced with problems similar to our own.

"P.M." at Hythe

MANY of my readers will know that in the booking hall at Hythe, on the Romney, Hythe, and Dymchurch Railway, there is an excellent collection of models for the edification of visitors waiting for the train. The latest addition to this display is the fine L.M.S. Pacific ¾-in. scale locomotive, built by Mr. G. H. Hill, of Brechin, and named "Percival Marshall," as a kindly compliment to myself. This engine was much admired at the last MODEL ENGINEER Exhibition, by the directors of the R. H. and D. Railway, Captain Howey and Mr. Terence Holder, and negotiations have resulted in its being given a place of honour in the Hythe collection. I am glad to say that the popular R. H. and D. Railway is now in full operation again, and recently celebrated its 21st birthday with a party attended by a large number of friends and railway officials.



An Attractive Marine Model

THE picture on this page shows a particularly neat example of marine engine modelling which is made additionally complete by the inclusion of the thrust-block and propeller. This engine was built by Mr. H. S. Weston, and was shown at the 1922 MODEL ENGINEER Exhibition. He modestly describes it as "a somewhat antiquated *ensemble* of nautical flavour," made by himself when a youngster, and first dabbling in the hobby. I think most of us would wish to compliment him on getting off the mark so exceptionally well. He tells me that he is now engaged on the construction of a $\frac{3}{4}$-in. scale Pacific locomotive, but so far this is only half complete. He says that his greatest interest is in the making and manipulation of the tools and equipment employed, rather than in the finished product, and adds that he finds the work most satisfying. Judging from the quality of his early craftsmanship, I imagine that the locomotive when finished will be a star turn, but I can assure Mr. Weston that he is not alone in finding his greatest pleasure in his tools and his workshop methods.

A Miner's Recreation

A READER who recently completed his studies for a professional career as a chemist tells me that he has been temporarily diverted to working in a coal mine. He says he finds the work extremely monotonous, but with shovel and pick in hand he does find some consolation in believing that he is of some small help to our great country in its time of trial. He concludes: "Since the completion of my studies, in January, I have frequently been in my workshop, file, etc., in hand, getting equipment ship-shape for the contemplated building of a 'Hielan' Lassie.' The feeling and move of a tool in the hand has given me great happiness and consolation amidst the strife and trouble which now surrounds us all." I think there is a fine spirit behind this confession and I am sure that later on he will be the happier, both in his workshop and in his professional career, for the knowledge that he gave useful national service in the mine.

Models at Barrow

I HEAR that the Barrow Model Engineering Club has been re-formed as a model section of the Post-War Civil Defence Association, and that the new organisation held a most successful exhibition at the end of March. Some excellent models of ships, planes, and engines were on view, and a working model of a steam-driven roundabout displayed outside the Alexandra Hut, in Abbey Road, tempted a great many of the public to venture inside to see the general model show. The Secretary is Mr. D. N. Wright, 37, Kendal Street, Barrow-in-Furness, and he would be glad to hear from other enthusiasts in the district.

A Plymouth Exhibition

THE Plymouth Society is busy preparing a fine display of models to be held at the "Barton" (Morris) Motor Company's showrooms, from April 21st to May 3rd. It is to be opened by the Earl of Mount Edgcumbe, and the Lord Mayor of Plymouth will preside.

Percival Marshall

*A Tandem Compound Engine

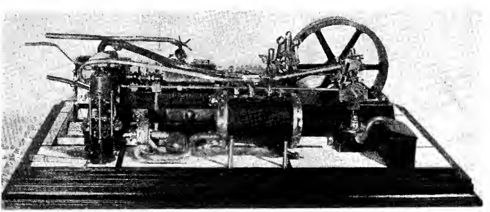
By "Crank Head"

THE front cover for the h.p. cylinder is of the usual design, with the exception that it is bored large enough to allow the enlarged portion of piston-rod to pass through, and is fitted with a neck bush which must be made in halves (see Fig. 5). The gland for this cover had also to be in halves ; it was made as shown in Fig. 6, a recessed ring fits over the spigot at A, and the flange of the gland at B. The studs for tightening the gland are so spaced that they pass through the edge of the flange, spreading of the gland at its outer end when tightening up the nuts is thus prevented.

The cover for the back end of h.p. cylinder is made with a recess deep enough to accommodate the h.p. piston nut, a neck bush being fitted which can be made in one piece with the gland. The l.p. covers are of the usual type and need no description.

At this stage, it would be as well to consider the pistons, both of which are alike excepting for size ; they are of mild-steel, and fitted with junk rings, as shown in Fig. 7. The h.p. piston is fitted with one plain split ring, with a couple of water grooves turned on the working surface ; this ring was made from an ornamental boss on the leg of an old iron bedstead. The boss cast direct on to the steel tube forming the leg of the bed was chilled, and as a consequence was as hard as—well, anything you like to think of, and difficult to turn until the hard surface was removed ; having managed to remove this hard outer skin, a piece of beautiful close-grained iron resulted, and made an excellent ring.

The ring for the l.p. piston is something of a novelty, for the design of which the writer takes no credit ; the full-sized commercial article being, it is believed, a product of the Standard Piston-ring Co. At any rate, it strikes the writer as being as near perfection as possible. Fig. 8, A and B, illustrates the two portions of the ring separated, and C the ring assembled. The top portion, A, is a ring with a collar on it, the diameter of the collar being 0.002 in. greater than the bore of the l.p. cylinder, and its depth equal to one half of the finished ring, the latter dimension, of course, being the width of groove in the piston. Having completed the turning of A, it is parted from the quill from which it was made, and portion B taken in hand ; this portion must also be the same width as the groove in the piston ; the external diameter 0.002 in. greater than the cylinder bore, and its internal diameter equal to smaller diameter of portion A. Before parting B from the quill the tongue piece C had to be marked off, and the ring reduced to its finished width, leaving the piece C the full width ; this operation was carried out by turning, although milling would have been just as efficient. A saw-cut was made at positions *e* and *f*, leaving C a few thousandths wider than the finished width ; another saw cut was made at *g*, and the piece between *g* and *e* filed out, the gap being wide enough to allow of a side knife-tool being entered. The lathe was then pulled around for a



portion of a rev., until the ring was reduced to the required width ; the ring was then parted off. Portion A was now taken in hand again, and part of the collar equal in width to the tongue $\dotplus$ 0.004 in. filed out, care being taken not to file this below the small diameter of the ring. A cut was now made with a fine hacksaw as shown in the sketch. Portion B was then cut at a point diametrically opposite to the cut in A ; the two portions of the ring were now placed together and fitted on piston. The pistons and rod were assembled, and placed in position in the cylinders, the front covers, and back h.p. cover being placed on rod, and the whole assembly temporarily jointed up.

*Continued from page 438, "M.E.," April 10, 1947.

The connecting-rod was made, as previously stated, from a forging. The forging was centred for turning; centres of gudgeon, crankhead, crankhead bolts and the jaws of the forked end marked off.

The rod was now mounted on the vertical slide in the lathe, and holes for crankhead bolts drilled. The bottom part of the crankhead was then parted exactly through the centre line at right-angles to the axis of the rod; if this operation is carefully carried out, no filing will be required at the junction of the parts, which, of course, will have to butt closely when brasses and bolts are in place. Two dowels to fit the crankhead boltholes were now turned a light driving-fit in the holes; the butting surfaces were tinned, put together and the dowels driven in, care being taken to see that the two portions of the rod were in close contact. The whole was then heated until the tin melted' then clamped together and allowed to cool. The rod was practically a solid piece, once more.

The turning of the rod was now proceeded with, and completed; it should have been previously stated that, before marking-off, one side of the forging was filed up to present a fair surface from which to work during the subsequent operations. The gudgeon-pin hole was next carefully drilled, using a sharp drill, and, as the pin was to be shrunk in, no further work on the hole was necessary. Having drilled this hole, the next operation was the boring of the housing for crankhead brasses.

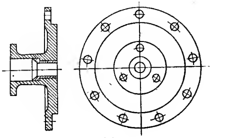


Fig. 5

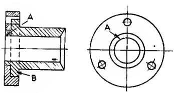


Fig. 6

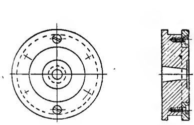


Fig. 7

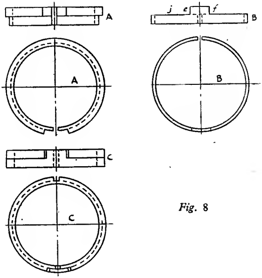


Fig. 8

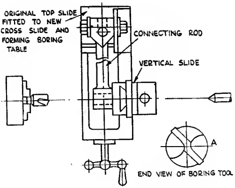


Fig. 9

A digression must now be made, in order to explain the method adopted for boring the housing. The lathe on which the whole of the turning for the engine was done is a Drummond 3½-in., of 1914-1918 vintage, and, although of this age, is in good condition; but it is not large enough to swing the connecting-rod. Some time ago the original transverse slide of the saddle developed a defect which prevented the facing of any object accurately, so modifications were carried out, which, unfortunately, meant the

loss of the automatic cross-feed, but this loss had to be accepted. The top of the saddle, including the transverse shears, was turned off, and a set of castings for a long slide (originally designed for milling on the Drummond round-bed lathe) was obtained. The slide was fitted up, dowelled and screwed down on the top of the lathe saddle; a new top slide rest made, and fitted to the transverse slide, thus providing a slide-rest which was completely compound, including the swivelling top slide for taper turning. The top portion of the original slide-rest was then adapted to fit the new transverse rest, and provided a very useful boring table. This modification of the saddle was a job requiring a good deal of care, but has amply repaid any labour expanded on the work. Fig. 9 will illustrate what was done.

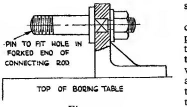


Fig. 10

Having said all this, a return may now be made to the connecting-rod. An angle-plate was bolted down to the boring-table at right-angles to the lathe axis, and a pin as Fig. 10, made to fit one of the holes in angle-plate, the other end being a fit in the gudgeon-pin hole. The pin was adjusted in the angle-plate so that its axis was parallel to the axis of lathe in both planes. The vertical slide was next mounted on the slide-rest, with its table at right-angles to the lathe axis; the rod was now placed on the pin in the angle-plate, and swung on this pin until the centre of crankhead bearing was coincident with the lathe centres. The rod was then clamped to the vertical slide, and a hole $\frac{1}{16}$-in. smaller in diameter than finished size drilled, the final cut through being made by a tool made from a broken twist-drill, turned to size, and shaped on the cutting end, as shown in Fig. 9A. The surface of the finished hole was not glass-like, but was circular, and in the right position, which is all that mattered.

The connecting-rod was now removed from the lathe, the forked end finished to size, the gudgeon pin turned and shrunk into the eyes; crankhead brasses, and bolts, made and fitted, and rod put aside as completed, and coupled up to the piston-rod, and crankshaft.

The eccentric-sheaves of cast-iron were turned from a piece of cast-iron (which, by the way, was once a portion of the front railings of a house in which the writer was living) and were first roughed down to approximately finished sizes, the throws marked off, drilled, and then bored to fit the crankshaft. Having proceeded so far, the slide-rest of vertical slide was mounted on the faceplate of the lathe, so that a pin similar to that in Fig. 10, excepting there was no square on it, screwed into the table of vertical slide was running truly; this pin was then turned to fit the bore of the eccentric sheaves. The sheaves were then mounted singly on the pin, and the table of vertical slide was then moved out of centre an amount equal to one half eccentric-throw and the turning of sheaves completed. This method may appear to be somewhat roundabout, but it gave good results, and in the long run time was saved.

The eccentric-straps were made from flat material one edge of each piece being filed up straight and square. The six pieces were then sweated together in pairs, the trued-up edges coming together obviated any fitting of butts after the straps were completed. They were now marked off to a template previously made and by the use of a saw drill and, of course, the file, brought down to nearly finished dimensions. The bolt-holes were now drilled and bolts made and fitted. The blank straps were now held in the chuck, faced on one side and bored to fit the sheaves; they were then held in the self-centring chuck by the bore, and the second side faced up.

The eccentric-rods were all built up, inasmuch as the foot of the rod was screwed on, and silver-soldered, the forked end of rod being made in a similar manner. The rods were now placed in the lathe, and turned all their length slightly tapered, and as they were no more than $\frac{1}{4}$ in. in diameter and one of them 12 in. long, there was nothing very amusing in that operation!

(*To be continued*)

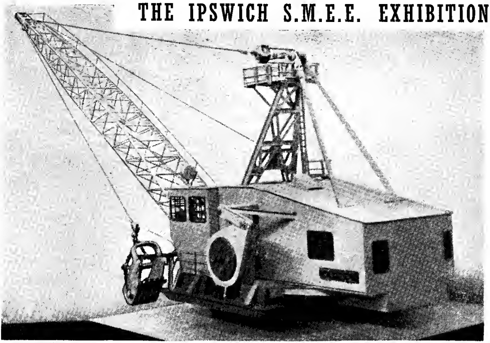
The Northern Association of Model Engineers

The first Annual General Meeting of the Northern Association was held at the Houldsworth Hall on Saturday, February 1st. Some sixty members and club delegates attended the meeting, representing seventeen of the twenty clubs at present affiliated. The following officials were elected for 1947:—Chairman, Mr. R. O. Harper, of Eccles; Vice-Chairman, Mr. W. Tomkinson, of Altrincham; Hon. Secretary and Treasurer, Mr. A. F. Duckitt, of Merseyside; Hon. Publicity Secretary, Mr. F. W. Waterton, of Altrincham; Hon. Competition Secretary, Mr. R. Lawton, of Whitefield; and Messrs. S. Lees, of Oldham; J. Denton, of Bolton; T. Crooks, of Rochdale, and J. W. Clarke, of Manchester, were elected council members.

After much discussion some modifications to the Rules were adopted and the rates of annual subscription were modified to reduce the expense to clubs with memberships of over fifty.

The programme of meetings for 1947 called for a meeting of delegates on the first Saturday of each month at the Y.M.C.A., Peter Street, Manchester. At the discretion of the Council a card vote system may be adopted to enable distant clubs to register their opinions in the event of being unable to send delegates to the meetings All applications for affiliation will be welcomed by the Hon. Secretary, A. F. Duckitt, 145, Bowring Park Avenue, Liverpool 16.

THE IPSWICH S.M.E.E. EXHIBITION

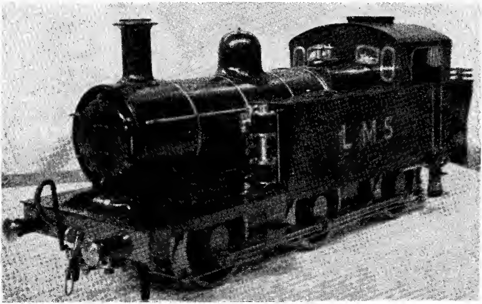


A working scale model Rapier walking dragline excavator (electrically driven). By S. Wade

DESPITE the arctic severity of this East Anglian February, the blackout and the fuel crisis, over 6,200 people had paid to see the Exhibition of Models in the Public Hall, Ipswich, when it closed on March 1st.

The prizes were presented by Mr. Vowles, the Borough Electrical Engineer, who was impressed by the very high standard of workmanship and ingenuity displayed.

The R.S. Lewis Championship Cup for the

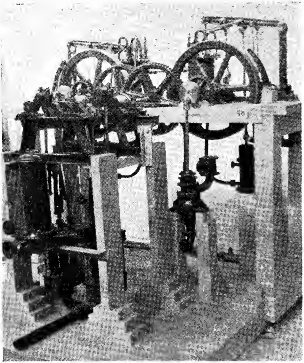


A 3½-in. gauge 0-6-0 locomotive. By J. W. Whistock

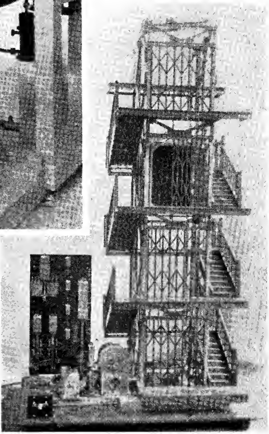
best model was won by S. Wade for his fine model of a Rapier Walking Dragline that attracted so much attention during the week. The R. R. Stokes Cup for the best work by a member under 21, was won by A. A. Last for an excellent group of tools and machine parts. The H. J. Wyatt Cup for the most original model was won by the Chairman of the Society, Mr. T. W. Hall. The other awards were as follows :—

Mr. H. J. Wyatt of Norwich, and Mr. Pilcher, who expressed their appreciation of the high general standard of the work exhibited. The standard of last year had been very good, but this year it was higher, showing every promise of being as good as any in the country in future.

In addition to the models, there were Cinema shows by the Central Office of Information, at which the latest films showing the technical



Left: A waterworks pumping plant, comprising two grasshopper engines with triple-throw pumps and gearing; and below: a scale working model of Waygood-Otis lift. By H. J. Wyatt



Aeroplanes.—1st prize, P. B. Wyatt; 2nd prize, R. A. Rush.
Locomotives.—1st prize, J. W. Whistock; 2nd prize, S. G. Cook.
Miscellaneous.—1st prize, P. M. de Souza; 2nd prize, R. H. Ostler.
Ships.—1st prize, D. H. Ventura; 2nd prize, E. M. Ward.
Tools.—2nd prize, S. G. Cook.

Open Competitions

Aeroplanes.—1st prize, J. I. Cross; 2nd prize, Miss A. Evans.
Miscellaneous.—1st prize, H. R. Clarke.
Ships.—1st prize, G. Moxome; 2nd prize, D. E. Kent; 3rd prize, J. L. Chumley.
Schoolboy.—1st prize, H. E. Meggitt.
Ladies Handicraft.—1st prize, Miss Shackleton; 2nd prize, Mrs. Coe.

A special award, on behalf of members of the Society, was presented to Ian Balfour, who is only 11, but showed such promise that the members had contributed towards a gift to encourage him in his efforts.

The judges of the Competition models were E. T. Westbury, of THE MODEL ENGINEER,

achievements of Radar, mechanised coal mining and other engineering feats were given. The workshop, operated by the Workshop Committee, created considerable interest, as visitors were able to watch lathes and other machines being used to make various parts for models.

*COMPRESSION-IGNITION ENGINES

By "Battiwallah"

HAVING discussed the general principles of compression-ignition engines, let us now get down to the details of construction of a 3-c.c. engine.

Fig. 1 shows the general arrangement and the principal dimensions ; the bore is $\frac{9}{16}$ in. and the stroke $\frac{3}{4}$ in.

Crankcase

In the selected design, the bearing end of the crankcase is integral with the main body. This makes a very strong and rigid job, and presents no machining difficulties. It does mean a casting, however, for it would be a somewhat wasteful and very tedious task to machine it from the solid. For those to whom the idea of complete construction from " A to Z " in the home workshop has a strong appeal, may I refer to my article on simple means of casting aluminium which appeared in THE MODEL ENGINEER for January 9th, 1947 It is fairly easy to combine the forms for the bearing-end and the main body of the crankcase into a single form.

The lugs for securing the back endplate can be provided for by cutting small slots in the form for the crankcase body and by fitting little semi-circular boxes over the slots, using pins for rivets, and immersing the whole form in sand so that the bottoms of the little boxes are stopped to prevent the molten metal from running out.

Some constructors may prefer to make the bearing end separately from the main body; others may have a preference for the back end-plate to be integral with the main body with a separate bearing end. Either choice lends itself to easy construction from solid material.

Let it be assumed that a casting to suit Fig. 1 is obtained. Centre it back and front as accurately as possible. Mount the casting between the lathe centres with a small driving-dog fixed on the small end and face the back end. Next, secure the casting to the lathe faceplate with the usual clamping-dogs so that the centring hole at the small end runs truly. Drill right through with 13/32-in. drill, holding the drill in the tailstock holder. Bore out with a boring tool to $\frac{7}{16}$ in. bare and finish with a reamer, if you have one ; otherwise finish off as accurately as you can with the boring tool. Now turn down a piece of steel for a length of roughly 2 in., so that it fits tightly in the bore, but not so tight that it needs a lot of forcing in, or there is a risk of cracking the small end of the casting. Push this $\frac{7}{16}$-in. mandrel into the bore for about $1\frac{1}{4}$ in. and grip the projecting end in the three-jaw chuck, then, taking light cuts, bore out the centre of the casting to a diameter of $1\frac{1}{8}$ in. for a depth of 23/32 in. Take out the turning-mandrel by gently tapping it with a " dolly " from the inside and grip the casting with the drill jaws of the three-jaw chuck inside the $1\frac{1}{8}$-in. bore. Face off the bearing end to length, which, from Fig. 2, is $2\frac{3}{8}$ in. With a $\frac{3}{8}$-in. bolt, secure the casting to an angle-plate fixed on the lathe faceplate, the bearing end being uppermost and with the holding-down lugs of the casting parallel to the faceplate. Face up the top of the casting to a trifle over the dimensions to the centre given in Fig. 2.

Now dismount the casting and carefully mark off the cylinder centre on the surface just machined ; remount as before on the faceplate with the cylinder centre-mark running truly. (It is preferable to go to the trouble of twice mounting the casting in the same way, rather than to mark off the cylinder centre first on the cast surface and face and bore with one mounting.) Make sure, of course, that the holding-down lugs of the casting are again parallel with the faceplate and take off light truing-up cut from the cylinder bolting face, to bring it down to size. Now bore through to the crank chamber to $\frac{9}{16}$-in. bore (full), as the piston skirt enters this bore at bottom stroke. At the top, open out to $\frac{11}{16}$ in. for a depth of $\frac{1}{16}$ in.

Make a template for the cylinder fixing-screw holes, for there are three sets of holes to be drilled, all of which must register. Fig. 3 shows a simple two-part template. Be careful to mark one side of the plate, so that it can be used the right way round ; placing the cylindrical piece in the top bore of the casting, mark off the cylinder fixing-screw holes by pointing them with a 3/32-in. drill. Drill the holes 5/64 in. diameter and $\frac{5}{16}$ in. deep, and tap 3/32-in. Whit. Use paraffin as a cutting lubricant if the tap tends to bind. Mill out the transfer passage $\frac{1}{4}$ in. deep with an end-mill.

The last little job on this casting must be left until the next part is made. It is drilling and tapping the fixing screws for the end-plate ; the holes in the crankcase are marked off from those in the end-plate.

Back End-plate

This is easiest turned from a piece of $1\frac{1}{2}$-in. diameter aluminium bar ; if such a thing is not handy, a piece can soon be cast by the methods described in the article previously referred to. Shaping this part is a simple turning job ; Fig. 4 gives the details. Shape the fixing lugs by filing. For those who prefer the screw-in type of end-plate, 24 t.p.i. is recommended ; in this case, the thread in the crankcase must be cut with the same mounting as that for turning the crank chamber.

It is advisable to make the main bearings

**Continued from page* 433, *" M.E.," April* 10, 1947.

from good quality mild-steel, and to fit them into the main casting at this stage, for reasons which will become clear when we come to the next part, which is the crankshaft. Forming them is a simple turning job; they must be truly concentric; Fig. 4, gives the dimensions. It is best to finish the bores with a small boring tool a few mils. under $\frac{5}{16}$ in. diameter. The external diameters must be such that the bushes are a nice drive fit in the casting—not too tight, or the latter will be split. Do not fit them in position yet, however.

Case-harden them next. If you are not *au fait* with this process, here are a few hints. Potassium ferrocyanide or Kasenit are suitable carburising agents to use; the procedure for either (in the amateur's workshop) is the same. Heat the work to a bright cherry red and immerse it quickly in the hardening agent—and don't inhale the fumes which are driven off. A quantity of the agent will adhere to the work. Reheat it to the same temperature, and maintain the latter for a few minutes until bubbling ceases; if deep penetration is required, give the work another

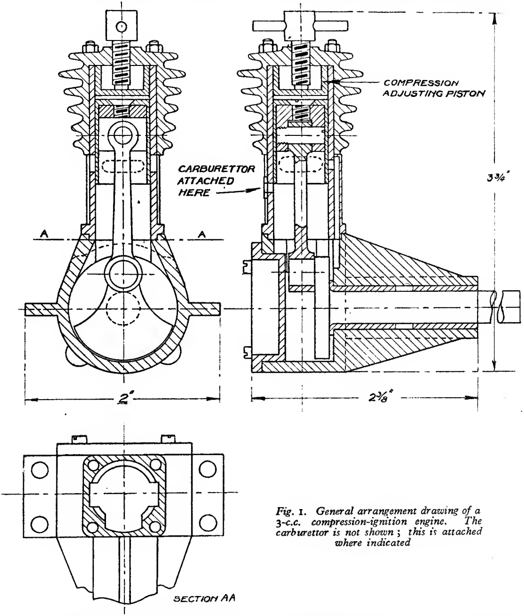


Fig. 1. *General arrangement drawing of a 3-c.c. compression-ignition engine. The carburettor is not shown; this is attached where indicated*

dip whilst red-hot in the agent. Quenching in cool water from the red heat, in the same way as cast steel is hardened, will impart a glass-hard skin to the work several mils. thick, and the tendency to distortion will be much less than with cast steel.

Clean the hardened bearing bushes with a wire brush and fit them into the crankcase casting.

Lapping is recommended for finishing the bores of the bearings. This, if properly done, will ensure a gas-tight seal and minimise wear.

A lap has first to be made. Taper down from 7/32 in. to 13/64 in. over a length of about 4 in. a piece of 1/4-in. round mild-steel rod about 6 in. long, the small end being steadied by the tail centre of the lathe. Ensure that the taper is straight—not bulged or hollowed along the length. Wrap the small end of this tapered rod with 16 s.w.g. annealed copper wire for a length of about 2 in., the turns being as close together as they will go. Remove this spiral from the taper rod, clean the latter with fine emery cloth, and coat it with plumber's black and let it dry. If the rod is not properly cleaned, the plumber's black will not adhere. Now replace the copper spiral on the rod and solder it thoroughly so that the solder runs well into the spaces between the turns. The function of the plumber's black is to prevent the solder from adhering to the rod. Give the rod a tap to drive it snugly into the spiral and turn the latter down to 5/16 in. diameter parallel. Take the spiral off the rod and split it longitudinally on one side and there you have a neat little expanding lap which, with careful use, will last a long time, provided it is not worked so hot that the turns of the lap itself are melted apart.

Expand the lap by pushing it along the tapered rod so that it is an easy fit in the bearing bores, these latter being *in situ* in the crankcase casting, of course. Put a slight smear of Axelite

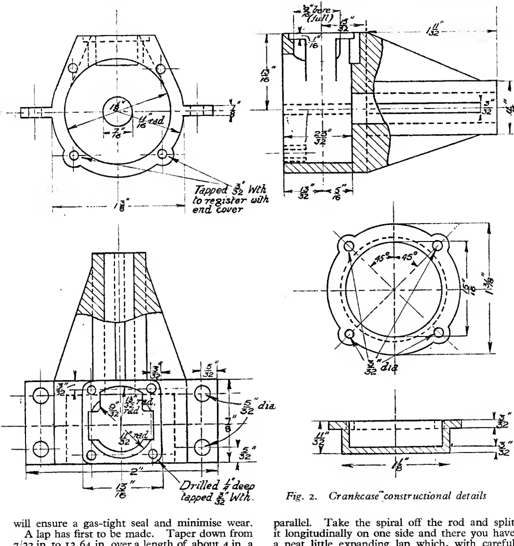


Fig. 2. Crankcase constructional details

grinding or lapping paste on the lap, thread the work over it, and with the taper rod steadied by the tail centre, run the lap at a fair speed—300-400 r.p.m. Frequently clean off the lap, and renew the lapping compound; continue the process until all tooling marks are removed, moving the work to and fro on the lap as the atter is revolving and expanding the lap as and when required to keep it reasonably tight in the bore. If the lap is a sloppy fit in the bore, the latter may become tapered; if it is too tight, the lap will overheat, and it may bind so tightly as to turn the bushes in their seatings. Moreover, a lap too tight does not cut so fast.

Roughly, a mil. or so can be removed in about 10 mins., to give an idea of the speed of the operation. Usually, three or four mils. have to be removed to eradicate the tool marks, provided the work has been accurately turned. This means, of course, that an allowance for lapping must be made if the intention is to finish to an accurate dimension.

When the lapping is completed, thoroughly wash the whole crankcase in paraffin and do not forget that the space between the two bearing bushes is a nice little trap for the abrasive.

Crankshaft

For those who possess only a treadle lathe, the next job is just "hard graft." It is the crankshaft. Do not be misled into the belief that work and effort can be lessened by making a built-up crankshaft, for you will almost certainly be disappointed and have to make one from the solid in the end; I've had some!

Take a 3-in. length of $1\frac{1}{4}$ in. diameter mild-steel of good quality, not a piece of war-time black wrought iron, which is full of cold-shuts, silicon inclusions, or whatever it is they are called. Accurately mark off the mainshaft and crankpin centres at $\frac{3}{8}$ in. apart. A good way to do this is to clamp the stock in a V-block, and with this on a true plane surface—your lathe bed if you have nothing else—mark off centre-lines on each end with a scribing-block. Turn the stock round 90 degrees, as checked by the try-square on the line just scribed, and mark off centre-lines as before. Without altering the scribing-block in any way and with a piece of exactly $\frac{3}{8}$ in. thick material underneath it, scribe a line again on each end. Accurately centre-pop the intersections of the lines, and the marking off is done. It does not matter if the first two sets of lines scribed are a little off-centre as there is $\frac{1}{16}$ in. material to spare.

Drill at the four pop marks with a Slocomb drill. Mount in the lathe between centres, using first the crankpin centres and turn down the crankpin $\frac{1}{4}$ in. long plus about 1/32 in. for final cleaning-up. Leave the pin about 3 mils. large in diameter to allow for the final lapping. Now mount on the mainshaft centres and turn down the mainshaft and crankweb, leaving the former about 3 mils. large, also for lapping. Fig. 4 gives the dimensions.

As regards the driving end of the crankshaft, there are the alternative methods of a cone-grip and screws and nuts for attaching the airscrew, propellor-coupling, or whatever is required. My choice is the screw and nuts because it is easy to disconnect the driven attachment without undue strain on the crankshaft; the cone fixing is apt to bind very tightly and to avoid damaging the shaft a drawing-off device is necessary. Fig. 4 shows the screw fixing; if this is adopted 32-pitch is recommended, and this should preferably be cut in the lathe, when the mainshaft has been turned down, without dismounting the work. The few odd mils. left on for lapping must, of course, be taken off the threaded part.

When turning the finishing cut on the mainshaft, a convenient means of driving the work held between the lathe centres is to bolt a piece of $\frac{1}{4}$-in. thick plate on the faceplate and with this to drive on the crankpin, placing a short piece of brass or copper tube over the pin to prevent it from being damaged.

If a saving of weight is desired, the crankshaft can be lightened by drilling it 5/32 in. diameter for a depth of about $2\frac{1}{4}$ in. from the crankweb end. Put a small plug in the hole, otherwise the volume of the crank-chamber will be increased and the transfer pressure will be reduced. Incidentally, there is little advantage to be gained by drilling an oilway to admit oil half-way along

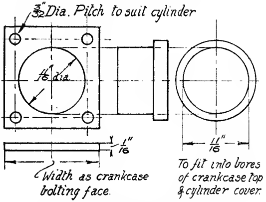


Fig. 3. Template for drilling the cylinder fixing-holes in the crankcase, cylinder flange, and the cylinder cover

the mainshaft bearing. It is rather the reverse, for the bearing seal is reduced, and the crankcase volume is slightly increased.

The next job is to case-harden the crankshaft. The procedure is just the same as was described for the bearings, except that more care is needed when quenching. In doing this, grip the screwed end of the shaft lightly in the tongs and plunge the work quite vertically in the water, otherwise it may be distorted. When the work is wire-brushed, it will be found to have a grey glass-hard surface, free from oxide scale; do not forget to clean out the turning-centre holes.

The final operation on the crankshaft is lapping the bearing surfaces. Firstly, laps must be made. This operation is best left until after the main bearings are finished if this has not already been done, as it is easier to fit the shaft to the bearings than the bearings to the shaft. for the latter may come out a mil. or so oversize.

To make the laps, turn up two copper discs

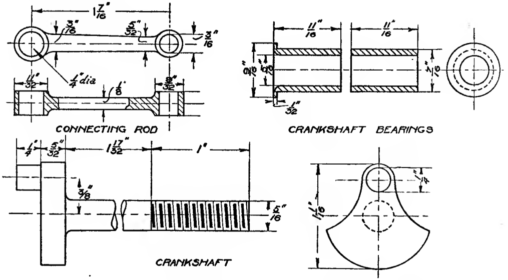


Fig. 4. Details of the connecting-rod, main bearings, and crankshaft

$\frac{13}{16}$ in. diameter to fit the screw-die-holder. If copper is not available, use mild-steel or brass. Make one disc $\frac{1}{4}$ in. thick and the other $\frac{1}{2}$ in. thick; drill a $\frac{1}{4}$-in. diameter hole in the centre of the first and a $\frac{5}{16}$-in. diameter hole in the centre of the second. Then make in each a diametrical saw-cut, leaving about $\frac{1}{16}$ in. uncut. If the brass or steel bodies have been used, drill out the centres so that copper tube pieces of suitable bores can be soldered in, finally saw-cutting as for the solid copper laps. Using these laps in the die-holder gives a means of easy adjustment and a nice control.

Before lapping the crankpin, "condition" the lap by running it for a few minutes on a piece of $\frac{1}{4}$-in. diameter mild-steel with a smear of lapping compound.

There is no ready means of driving the crankshaft for lapping the crankpin so the easiest thing to do is to reverse the process and drive the lap by gripping it in the three-jaw chuck just tightly enough not to bind on the crankpin. With just a touch of lapping compound on the pin it will not take many minutes to lap it down to 0.250 in. With the right grade of lapping compound, a mirror-like surface will be obtained. With a protecting-piece over the crankpin, drive the crankshaft with the piece of $\frac{1}{4}$-in. material bolted on the faceplate, as previously explained, between the lathe centres. Put the $\frac{5}{16}$-in. diameter lap in the die-holder and, using the lapping compound sparsely and frequently renewing it, work the lap steadily along the main bearing surface. As it works free, tighten it a little; the high spots can be felt by the grip of the lap and they should be worked down. If lapping is new to one, a little practice soon gives one the "feel" of the job. Never swamp the lap with abrasive and oil; the mixture is in a state of movement in the hollows of the work and is removing material therefrom and the surface cannot be finished truly. For the finish, the lap should be run almost dry and fairly tight; it *must* have the same tightness of feel along the whole length of the bearing surface. If you have not done a job of this kind before, you will be astonished by the results, both from the degree of accuracy and finish.

The shaft must be tried from time to time for fit in the bearings. If the latter are known to have finished oversize on completion of lapping, then a suitably greater allowance for lapping than that already mentioned must be made on the finishing turning cut of the crankshaft. With both the crankshaft and the bearings truly lapped, the former should run in the bearings quite freely without any rock.

(To be continued)

Small Screwdrivers

"M.B.W." writes.—"With reference to the letter on 'Small Screwdriver Blades,' by E. Hudson, in THE MODEL ENGINEER, dated March 27, 1947, I have always made jewellers' screwdriver blades from Stubbs 'pivot wire.' It is put up in bundles of 4 in.-6 in. lengths, from, I think, 18 'thou.' and upwards. It is sold blue and in that state is just right for screwdriver blades, and can be filed. It can be bought from watch material dealers, such as those in Clerkenwell Road. But if your correspondent will send me a postcard, I shall be very pleased to present him with enough of this material to make his blades. What sizes are required altogether?"

"L.B.S.C."

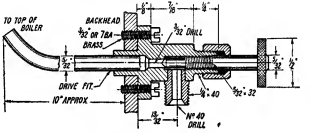
BOILER FITTINGS FOR "HIELAN' LASSIE"

BEFORE proceeding in detail with the construction of the rest of the backhead adornments for the "Lassie," will builders of "Juliet" please take careful note of the following. All my boiler fittings and mountings are practically "standard"—another word on my list of "detestables" but unfortunately there doesn't seem to be a more pleasant substitute for it! They differ only in size, according to the type of engine; and the fittings described below for the "Lassie," will do equally well for "Juliet" with hardly any variation. If builders of the little engine will, therefore, as we used to say at school, "read, mark, learn and inwardly digest" the following notes, it will save a lot of unnecessary repetition in the description of the boiler for "Juliet," which, is now in hand for the press.

Injector Steam Valve

It is absolutely essential for the injector to be supplied with dry steam, otherwise it won't operate; so the steam-valve is made with a flange for attaching it to the backhead, and furnished with an internal pipe leading to the top of the boiler barrel near the dome. Our advertisers may probably supply castings for these small fittings, but if same are not available, the fittings are easily built up.

To make the injector steam-valve, chuck a piece of ¾-in. round rod in three-jaw. Bronze or gunmetal is best, but brass will do if nothing better is available. Face the end, centre, and drill down a full 1¼ in. depth with No. 42, or 3/32-in. drill. Open out to about ⅜ in. depth with No. 30 drill, and bottom the hole to 9/16 in. depth with a ⅛-in. D-bit. Further open out ⅛ in. depth with No. 21 drill, and tap the No. 30 section 5/32 in. by 32 or 40, the former preferred, as it gives a much quicker opening and closing. Don't run the tap in far enough to destroy the D-bitted seating. Turn down 11/16 in. of the outside to ⅜ in. diameter; turn down ¼ in. of that, to ¼ in. diameter, and screw it ¼ in. by 40. Part-off at 1 1/16 in. from the end. Reverse in chuck, gripping by the reduced part, and turn down ¼ in. of the other end to ¼ in. diameter. Leave it plain; don't screw it. Open out the centre hole to 5/16 in. depth with No. 23 drill. Next, at 13/32 in. from the shoulder, drill a 3/16-in. hole, breaking into the central passageway just clear of the valve-seat; see sectional illustration. In this, fit a ¼-in. by 40 union nipple, made as described for the whistle-valve, and silver-solder it in. Run the D-bit and 5/32-in. tap in again, in case there are any burrs left on the inside. Drill four holes with No. 43 drill equidistant around the flange.



Injector steam valve

A piece of 5/32-in. rustless steel, phosphor bronze, or nickel bronze, 1¼ in. long, is needed for the valve-pin. Chuck in three-jaw, face the end, and turn down about 7/32 in. length to 7/64 in. diameter, then form a cone point on the end, either by slewing the top slide around to 45 degrees and turning it, or by taking a couple of sweeps with a fine file held at the correct angle, across the end of the rod whilst the lathe is running fast. The latter is all I ever do, and I'm never troubled with leaky valves. Pull the rod a little farther out of the chuck, and put about 5/16 in. of thread on it, to match the tapped hole in the valve. Use a die in the tailstock holder. Beginners particularly note—*never* screw work in the lathe, by holding a die to it in an ordinary hand die-stock, as you very seldom get a true thread by that means.

Reverse the pin in the chuck, and file a square on the other end; I've described how to do that so many times, that followers of these notes ought to be able to do it in the dark, upside down and backwards. Turn up a little wheel from ½-in. round rod (dural makes nice handwheels) a kiddy's practice job needing no detailing. Drill four holes in it in lieu of spokes, and one in the middle, which can be squared by driving a square punch through it; simply an inch or so of ⅛-in. square silver steel, squared off at one end, bevelled a little at the other, hardened and tempered to dark yellow. I use a short punch and knock it clean through, hence the bevelled end, which is the trailing end, the bevelled part counteracting any tendency of the hammer to form a burr which would prevent the punch passing through the hole. I hope our experienced brothers of the craft will not be too impatient at digressions for beginners' benefit, but they are sadly needed. My correspondence tells many a tale of woe! Drive the wheel on the squared part of the valve-pin, and rivet over slightly.

The gland-nut is made exactly the same as a union-nut, so that also doesn't need any more detailing. Pack it with a few strands of graphited

yarn. While you are on the job, make a similar valve-pin, wheel and gland-nut for the blower-valve, and fit them. Regarding wheels, I find that some correspondents complain that their fingers slip on the rims of little handwheels. I always knurl mine with a file, not a knurling wheel. The file is pressed down on the wheel before completely parting off, and the lathe belt pulled back and forth by hand, letting the file follow the movement of the wheel. I get far better knurls that way, than ever I did with a regular knurling wheel. When doing this job I always think of the late Henry B. Selden, of New London, Conn., U.S.A. When he heard I was over there, and staying with a mutual friend, the late Calvert Holt, he drove 120 miles through a snowstorm to see me, got ditched, had several skids, and " ran " a red stop-and-go light.

I was using Holt's South Bend lathe to make some small fittings, and Harry B. came down into the shop and started talking. As I knurled a wheel as above, he suddenly " shut off," and there was dead silence as I did another one. I looked around at him, and the puzzled look on his face would have got him a job at Hollywood ; so I asked what had bitten him. He said, " Well, that's darned funny—I watched you do that twice, and yet I'm blessed if I know how you did it ! " So I expounded. What " caught " him, was the fact that the lathe was driven direct by a reversible motor, with variable speed, and I was operating the reversing switch to get the back-and-forth movement whilst pressing the file on the rim of the wheel. Anyway, if you can't get a sharp knurl, sufficient to prevent finger-slip, either put a small peg in the rim of the wheel, *a la* L.M.S., or else drill a No. 49 hole through the end of the pin, and drive in a bit of 15-gauge spoke wire to form a cross handle, like the ones on the blowdown valves of Billy Stroudley's water gauges, and dispense with a wheel.

Drive a piece of 5/32-in. thin walled copper tube into the end of the valve, as shown in the sectional illustration ; this should be about 10 in. long, and bent so that it touches the top of the boiler shell when the valve is in place. It can be soldered in, if you like, or silver-soldered when doing the nipple ; any way will do, as long as it can't come adrift from the valve. At $\frac{7}{8}$ in. from the vertical centre-line of the backhead, and about $\frac{1}{8}$ in. below the level of the regulator-spindle, drill a $\frac{1}{4}$-in. clearing hole in the backhead. File off any burr, then fit the valve to it, just like fitting one of the cylinder covers, securing it with four 8-B.A. round-head brass screws, and a 1/64-in. Hallite or similar jointing washer between the flange and the backhead.

Steam-gauge Syphon

This is a simple job. Chuck a bit of $\frac{5}{16}$-in. round rod—brass will do, there is nothing to wear—face the end, centre and drill down $\frac{3}{8}$ in. depth with 3/32-in. or No. 42 drill. Turn down $\frac{3}{16}$ in. of the end to $\frac{3}{16}$ in. diameter, and screw $\frac{3}{16}$ in. by 40. Part off a full $\frac{1}{4}$ in. from the shoulder. Drill a hole in the side with No. 32 drill, fit an inverted 1-in. swan-neck of $\frac{1}{8}$-in. copper tube into it, and silver-solder it. The other end of the swan-neck carries a union-nut and collar for the steam-gauge. The latter can be purchased from our advertisers, or made according to the instructions I gave in these notes some time ago. Beginners are advised to buy the gauge, as it needs to be thoroughly reliable, and tested to indicate correct working pressure, and I wouldn't recommend any beginner to undertake a tricky bit of instrument-making. A gauge $\frac{3}{4}$ in. or $\frac{7}{8}$ in. diameter, reading 0 to 120 or 150 lb. per square inch, is suitable for the " Lassie." Most commercially-made gauges have the end of the connecting-screw squared off, instead of being countersunk for a union nipple—why, goodness only knows !—so I have shown a flat collar on the end of the swan neck in the illustration ; but if you like to countersink the gauge screw, or if you get one that is countersunk, fit a cone to suit. Drill a 5/32-in. hole close to the edge of the backhead, about $1\frac{3}{8}$ in. from the top of the firebox shell ; tap it $\frac{3}{16}$ in. by 40, and screw in the completed syphon with a taste of plumbers' jointing on the threads.

Clack-boxes or Check-Valves

Chuck a length of $\frac{3}{8}$-in. round bronze or gunmetal rod in the three-jaw. Face the end, centre deeply with size E centre-drill, turn down $\frac{1}{4}$ in. of the outside to $\frac{1}{4}$ in. diameter and screw $\frac{1}{4}$ in. by 40. Part-off at a full $\frac{3}{4}$ in. from the end. Reverse in chuck ; centre, and drill right through with No. 24 drill. Open out to about $\frac{1}{4}$ in. depth with $\frac{1}{4}$-in. drill, and bottom to $\frac{3}{8}$ in. depth with $\frac{1}{4}$ in. D-bit, poke a 5/32-in. reamer through the remnants of the No. 24 hole. If you haven't a 5/32-in. reamer, use a taper broach, and only put it through far enough to true the hole at the bottom of the recess. Slightly countersink the large end ; tap 9/32 in. by 32, taking care not to damage the seating, and skim off any burr at the end.

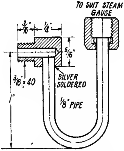
Drill a $\frac{3}{16}$-in. hole in the side, just above the seating, in which is fitted the boiler connection. Chuck the $\frac{3}{8}$-in. rod again ; face, centre, and drill down about $\frac{5}{8}$ in. depth with $\frac{1}{8}$-in. drill. Turn down $\frac{1}{4}$ in. of the outside to $\frac{1}{4}$ in. diameter, and screw $\frac{1}{4}$ in. by 40 ; part-off at a full $\frac{1}{2}$ in. from the end. Reverse in chuck, holding either by the threads, or in a tapped bush held in three-jaw ; I keep a number of tapped bushes of different sizes handy to my Boley lathe, for use when making these small fittings. Turn the outside to the profile shown, and then turn down $\frac{1}{16}$ in. of the end to a tight fit in the hole in the side of the clack body ; squeeze it in, and silver-solder it. After cleaning up, drop a $\frac{3}{16}$-in. rustless steel ball on the seating, and holding a bit of brass rod on the ball, give the rod one sharp crack with a hammer. Beginners usually over-do the " biffing," and wreck the seating.

Take the depth from ball to top of clack-box with a depth gauge—young Curly's depth gauge was a bit of wire, or one of his mother's hat pins, stuck through a bus ticket. Chuck the $\frac{3}{8}$-in. rod again, and turn down the length indicated by the depth gauge, to 9/32 in. diameter, screwing it 9/32 in. by 32. Countersink the end sufficiently to allow the ball 1/32 in. lift. You can either part off at $\frac{7}{16}$ in. from the end,

and file a square or hexagon $\frac{1}{8}$ in. long on it, or part off at $\frac{5}{16}$ in. from the end, reverse in chuck, and drill a $\frac{1}{8}$-in. hole about $\frac{1}{8}$ in. deep in the middle.

Chuck a piece of $\frac{1}{4}$-in. hexagon brass rod, turn a pip on it a tight fit for the hole in the cap, part off $\frac{1}{8}$ in. from the shoulder, squeeze it in the cap, silver-solder it, then chuck the cap by the threads, and chamfer the corners of the hexagon. That gives you a decent hexagon spanner-hold without the trouble of filing it. Smear the threads with plumber's jointing before screwing home the cap, but take care none gets inside the ball chamber. Two clacks are needed.

Drill a $\frac{1}{8}$-in. hole at each side of the backhead, about $\frac{1}{4}$ in. from the edge and $2\frac{1}{2}$ in. from the bottom; open out with 7/32-in. drill, and tap $\frac{1}{4}$ in. by 40. Screw in the clacks with a bit of plumbers' jointing around the threads. It does not matter about getting them parallel to the sloping backhead; they work just as well on the slant, as they would if exactly vertical.

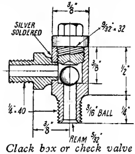


Steam gauge syphon

Washout-Plug and Blowdown-Valve

The wash-out plug is simply a slightly enlarged variation of the clack-box cap described above; the end is faced off flat, and the spanner hold can either be filed square or hexagon, just as you please. The illustration gives the dimensions. The blow-down valve is merely an outsize screw-down valve, like the injector-valve, but without any gland. Chuck a bit of $\frac{1}{2}$-in. bronze or gunmetal rod in the three-jaw; turn down $\frac{5}{8}$ in. length to $\frac{7}{16}$ in. diameter; face, centre, and drill down a full 1 in. with 7/32-in. drill. Open out and bottom with 9/32-in. drill and D-bit to $\frac{9}{16}$ in. depth, and tap $\frac{5}{16}$ in. by 32 or 26. Part off at $\frac{15}{16}$ in. from the end; reverse in chuck, turn down $\frac{3}{16}$ in. of the end to $\frac{3}{8}$ in. diameter, and screw $\frac{3}{8}$ in. by 32. Drill a $\frac{5}{16}$-in. hole in the side, $\frac{3}{8}$ in. from the shoulder, just enough to miss the valve-seat; and in this, fit a socket. Chuck a bit of $\frac{3}{8}$-in. round rod; face, centre, and drill 9/32 in. for about $\frac{1}{2}$ in. depth. Tap $\frac{1}{4}$ in. depth of this, $\frac{5}{16}$ in. by 40. Part off $\frac{3}{8}$ in. from end, reverse in chuck, turn $\frac{1}{16}$ in. length to a tight squeeze fit in the hole in the side of valve-body, squeeze it in, and silver-solder it. Run in the tap to remove any burrs.

The valve-pin is made, same as the injector steam-valve pin, but larger; $\frac{5}{16}$ in. round rod is used, and the pin is $\frac{7}{8}$ in. overall length, the end being squared, as shown in the illustration, to take a spanner or box key. Drill a $\frac{1}{8}$-in. hole at each bottom corner of the backhead, $\frac{1}{2}$ in. from bottom and $\frac{3}{8}$ in. from the side; open out with letter R or 11/32-in. drill, tap $\frac{3}{8}$ in. by 32, screw the washout-plug in the left hole, and the blowdown-valve in the right hole. When the boiler is mounted on the chassis, a short bit of thin-walled $\frac{5}{16}$-in. pipe will be screwed

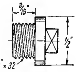


Clack box or check valve

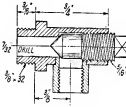
into the socket, to project down through the footplate and blow the contents of the boiler into the ash-pit before washing it out. All boilers need a periodical wash-out, just the same as in full-size practice, otherwise they "fur up" and lose efficiency.

Water-Gauge

The water-gauge is the engineman's nightmare. When a steam driver first takes to Milly Amp, he gleefully exclaims "Wot—no water-gauge?" On the old Brighton radial tanks it was a case of one eye on the steam-gauge and the other on the water-gauge all the time, which didn't leave the unfortunate drivers much to look out for signals—something like the Wild West cowboy who had a six-shooter in each hand and a lasso in the other! On a little locomotive, a reliable water-gauge is a *sine qua non*, and the kind shown in the accompanying illustration is what your humble servant found the best, after much experimenting. It is quite simple to make, the upper fitting being very nearly a replica of the clack-box described above, except that the body is made from $\frac{5}{16}$-in. brass rod; the lower end is not reduced in diameter, but



Washout plug



Blowdown valve

screwed $\frac{5}{16}$ in. by 32 for a few threads, and furnished with a gland-nut to suit. The fitting is drilled $\frac{3}{16}$ in. clearing (No. 11 drill) right through, to take a $\frac{3}{16}$-in. glass, and the top is tapped 7/32 in. by 40, and provided with a screwed cap like that on the clack-box.

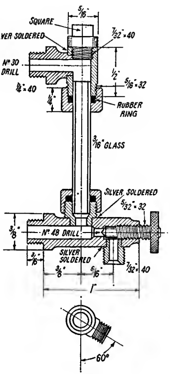
The lower fitting is a little more elaborate, as it contains the blowdown-valve. Chuck a piece

of $\frac{3}{8}$-in. round rod in the three-jaw, with a little over 1 in. projecting. Turn down $\frac{7}{8}$ in. length to $\frac{5}{16}$ in. diameter, using a round-nose tool so as to leave a radius at the end of the cut, and then turn a small radius at the outer end, as shown in the sectional illustration, for appearances' sake. Face, centre, and drill about $\frac{3}{4}$ in. depth with No. 48 drill. Open out for about $\frac{1}{4}$ in. depth with No. 30 drill, and bottom the hole to $\frac{3}{8}$ in. depth with $\frac{1}{8}$-in. D-bit. Tap the No. 30 part 5/32 in. by 32 or 40. Part-off at $1\frac{3}{16}$ in. from the end. Reverse in chuck, and turn down $\frac{3}{16}$ in. of the other end to $\frac{1}{4}$ in. diameter; screw it $\frac{1}{4}$ in. by 40, then centre and drill down to a depth of $\frac{11}{16}$ in. with a No. 30 drill, meeting and partly cutting away the No. 48 hole.

Be careful over this bit. At $\frac{3}{8}$ in. from the shoulder, drill a $\frac{3}{16}$ in. hole in the side of the fitting, breaking into the central passage-way. At $\frac{5}{16}$ in. farther along, drill a 5/32-in. hole one-third of the way around the circumference, so that when the union nipple is fixed in it, same will be 60 deg. from the vertical position; see detail sketch. There is no need to trouble about setting the angle with a gauge, protractor, or any other geometrical appliance, because the big idea is simply to ensure that the blowdown-pipe is clear of the firehole-door when same is opened, to admit some of what are now literally "black diamonds." Incidentally, at the present moment I don't possess enough to give old "Ayesha" a run; our heating boiler has been out for a week, goodness only knows when it will be lit up again.

The union nipple mentioned above, is just the same as the 7/32-in. by 40 nipple in the whistle-valve, so I need not detail it out again. The nipple in the $\frac{3}{16}$-in. hole first mentioned, is made the same way, from $\frac{5}{16}$-in. round brass rod. Chuck a bit in three-jaw, face the end, centre, and drill to $\frac{3}{8}$ in. depth with No. 30 drill. Open out to $\frac{1}{8}$ in. depth with No. 11 drill; put a few 5/32-in. by 32 threads on the outside, and part off at $\frac{1}{4}$ in. full from the end. Reverse in chuck, and turn a spigot $\frac{1}{16}$ in. long, to a tight fit in the $\frac{3}{16}$ in. hole in the fitting. Squeeze in both this and the blowdown-nipple, silver-solder them both at one heat, quench in pickle, wash off and clean up. The valve-pin and hand-wheel are made, same as for the injector steam valve, except that the overall length is $\frac{5}{8}$ in. The gland-nut is made from $\frac{3}{8}$-in. hexagon brass rod, same as described for union nuts.

To erect the water-gauge, scribe a vertical line on the backhead $\frac{3}{8}$ in. to the right of the regulator spindle. About $\frac{1}{4}$ in. from the top, drill a $\frac{1}{8}$-in. pilot hole, open it out to 7/32 in., and tap $\frac{1}{4}$ in. by 40. Repeat process $1\frac{3}{4}$ in. below it, and file off any burrs. Screw in the fittings with a smear of plumbers' jointing on the threads, and be quite sure they are dead in line when tightened up; beginners note that the easiest way of ensuring this, is to drop the No. 11 drill, shank first, through the top fitting. It should enter the recess in the gland of the lower fitting, quite easily, without any coaxing; and both the gland-nuts should turn quite easily by finger pressure only, with the drill in place.



Water gauge

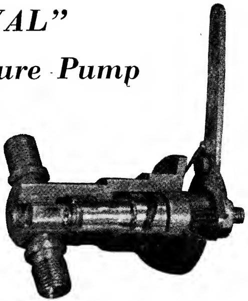
The glass is a piece of $\frac{3}{16}$-in. glass tube approximately $1\frac{3}{8}$ in. long, which can be cut easily by nicking it with a three-cornered file, and snapping with your fingers. The packing-rings are rubber; get a bit of rubber tube which, when slipped over the glass, will just enter the gland-nuts. If too large, chuck a bit of $\frac{3}{16}$-in. round rod in three-jaw, slip the rubber on it, run the lathe as fast as possible, and hold a bit of fine glass-paper against the rubber, which will speedily reduce it to size. If you apply a wet discarded safety-razor blade to the revolving rubber, at bare $\frac{1}{8}$-in. intervals, you will find that when you push the rubber off the rod, your packing-rings are already made. Wet the glass, insert in the top fitting, put on a ring, then the two gland nuts back to back, then another ring, and let the glass drop into the bottom recess. The gland-nuts can then be slid into position, taking the rings inside them, and can be screwed home.

Beginners note: the glands need to be little more than finger-tight, *as the glass tube must be free to expand.* Any driver or fireman will confirm that the most frequent cause of broken glasses, is tightening up the gland-nuts too much.

Allow for expansion!

This should be obvious, even to the veriest Billy Muggins; and yet designs for "improved" water gauges have been put forward, in which the glass was clamped rigidly top and bottom, with packing-washers at each end instead of glands, and not the slightest provision for the glass to expand at all! Anyway, the fitting just described, is the kind I always use on my own engines, and it has never failed to give complete satisfaction in every way, indicating correctly, and requiring only an occasional clean-out.

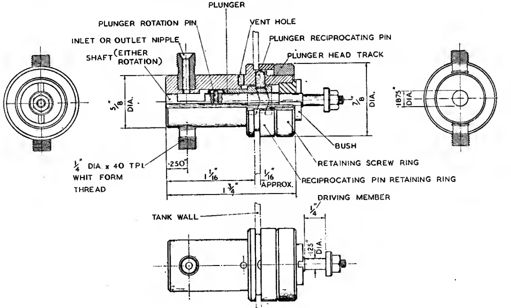
The "AUSWAL" Mechanical Pressure Pump



THE design of a pump to handle very small quantities of fluid, at high pressure and with positive metering, is always a difficult matter, as it is impracticable to reduce the details of large pumps in true scale proportions, with the result that dead spaces in valve pockets and passages are liable to give trouble, and problems also arise in valve design, often resulting in sticking or erratic action of the valves. The latter trouble is perhaps the most prevalent of all in very small pumps, and although ordinary lift valves of the "mushroom" or ball type—generally the latter—have been made to work more or less successfully in minute sizes, their complete reliability and immunity from trouble is always extremely dubious.

An obvious remedy for valve troubles of this nature is to use pumps of the "valveless" type, or to speak really correctly, pumps in which the valve events are controlled mechanically by rotary, reciprocating or oscillating motion of the main working parts. The rotary type of pump, it may be mentioned in passing, is theoretically capable of working efficiently in any size, but great practical difficulties arise in making it to sufficiently exact limits to avoid serious leakage or "slip" when its size is very small, and for the particular conditions referred to above, a reciprocating plunger pump gives the most consistent results.

One of the simplest forms of "valveless" plunger pumps is the oscillating type, basically similar to the very familiar steam engine in which valve events are controlled by the motion of the cylinder block on a stationary port face. Pumps of this type have been made in a wide varity of forms and sizes, for performing different duties, and in particular, for pumping lubricating oil in small quantities to the internal parts of engines.



The "Auswal" rotary-reciprocating plunger pump

The tiny ratchet-driven oscillating mechanical lubricator is well-known to all model engineers, being fitted to many model locomotives, while very similar pumps, driven by worm reduction gearing, are used for forced lubrication on model petrol engines.

Another equally successful, but less fully understood type of "valveless" pump is that in which the plunger is given a combined reciprocating and rotary motion, so that it will function both as a displacer as a rotary valve. This form of pump has the advantage that, by providing for adjusting the angular relation or "timing" of the two orders of movement, its output volume can be controlled, positively and without slip or leakage, from zero to full discharge. For some classes of work, metering control is extremely valuable, or even essential; and it may be mentioned that pumps of this type have been used successfully for oil injection on diesel engines. Their most popular application, however, is for bearing lubrication of high speed engines, in cases where a controlled supply under pressure is required, such as in the "once-through" or "total-loss" system, as distinct from that in which a larger volume of oil is kept in constant circulation. At least one well-known model petrol engine is fitted with a pump of this type.

A very interesting and extremely well-made pump of this class has recently been put into production in a size which is applicable to many purposes in model engineering. It consists of a bronze cylinder, having at one end a flange which may conveniently be used for mounting purposes, and at the other, diametrically opposed union connections for suction and delivery pipes. In the centre of the cylinder is a shaft which is closely end-located in a gland or packing bush at the outer end, and closely fitted to the bore at the inner end of the cylinder. A sleeve is fitted over this shaft, free to slide upon it, but keyed rotationally by a cross pin in a slot, and externally fitted in a counterbore in the barrel of the cylinder. The end of the sleeve is enlarged, and a cam groove is cut in it, to engage a pin set in the wall of the cylinder, which imparts a reciprocating motion to the sleeve as the latter rotates.

A flat is cut on the end of the centre shaft, which thus acts as a rotary valve, uncovering the suction and delivery ports in turn as the sleeve reciprocates in the counterbore of the barrel, the annular space in which forms the working chamber of the pump. The displacement is thus equal to the area of the annulus, multiplied by the amount of reciprocating movement. Owing to the positive control of the ports, the slip is practically negligible; in other words, volumetric efficiency is extremely high, so that the pump can be used to meter fluids to a high degree of accuracy, which is maintained over a wide range of speed.

The drive to the centre shaft may be applied in any convenient manner, but in view of the probable use of the pump in the mechanical lubricator of a model locomotive, a ratchet drive is fitted to the example shown. As it is usual to regulate the feed of such lubricators by adjusing the stroke of the ratchet lever (so that the number of teeth on the ratchet gathered on each stroke is altered as required), it is not necessary to provide any further control on the pump itself. In most cases the pump may conveniently be mounted on the oil reservoir, so that the barrel is completely immersed and oil-sealed, and no suction pipe line is required.

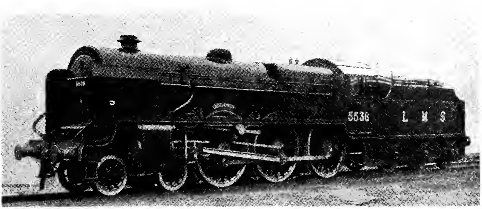
The form of ratchet gear fitted is extremely interesting and ingenious, as it eliminates the need for springs on either the feed or back-stop pawls, which are made to work on a similar principle to the escapement pallets of a clock, thereby ensuring positive engagement with the ratchet wheel.

Efficient working of a pump of this type can only be ensured if it is accurately made, and fine clearances maintained under all working conditions. The centre shaft and sleeve of this pump are made of hardened steel, ground to a very fine limit of precision, and the bronze barrel is bored by special methods which ensure exact diametric and concentric accuracy. The test of a pump fitted with a hand crank, and mounted in a small oil tank filled with light, non-viscous oil, showed that pressures up to 800 lbs. per sq. in. could be obtained quite easily. Although this pressure would gradually leak away when the pump was stopped, it could easily be maintained, should this be considered desirable, by the simple expedient of fitting a check valve in the delivery line. At moderate pressures, up to about 100 lbs. per sq. in., leakage was negligible, and pressure could be held for a long time.

Apart from the application of the pump for high pressure lubrication, it could also be used for a water feed pump, providing that non-rusting working parts were fitted, and it is also applicable to many other purposes, such as pressure supply to small hydraulic devices. The makers of this device are Auswal Small Tools Ltd., 193, London Road, Kingston-on-Thames to whom all enquiries concerning it should be addressed.

Handley Page Model Engineers

THE Sports Club attached to the famous firm of Handley Page now has a flourishing model engineering branch. Sections have been formed for locomotives, racing cars, power boats and planes, and a workshop equipped with a $4\frac{1}{2}$-in. screwcutting lathe is at the disposal of members. We hear that three $3\frac{1}{2}$-in. gauge locomotives are under construction in the workshop, and a portable multi-gauge track is being built. In the power boat section a *Javelin* destroyer from THE MODEL ENGINEER articles is nearly completed. Mr. Harvey is the Hon. Secretary and the address is Claremont Road, Cricklewood, N.W.2.



" Patriot " class locomotive No. 5538 *with parallel boiler*

NOTEWORTHY L.M.S. REBUILDING

Conversion of "Patriot" 5x Class to Class 6 Taper Boiler Engines

THE L.M.S. Railway's "Patriot" class of 3-cylinder 4-6-0 engines, fitted with parallel boilers and bearing the power classification 5X, were originally classified as rebuilds of the 4-cylinder "Sir Gilbert Claughton" class of the former L.N.W.R. In all, 52 of these engines were completed during the years 1930-1934, to the designs of the late Sir Henry Fowler.

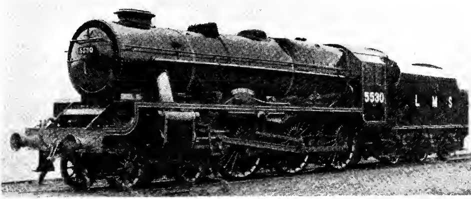
New Boilers

A number of the engines are now falling due for new boilers and are being rebuilt to the designs of the Chief Mechanical Engineer, Mr. H. G. Ivatt, M.I.Mech.E., so as to take the type 2A taper boiler, which has been used with conspicuous success on the "Royal Scot" conversions as well as on two of the "Silver Jubilee" class engines.

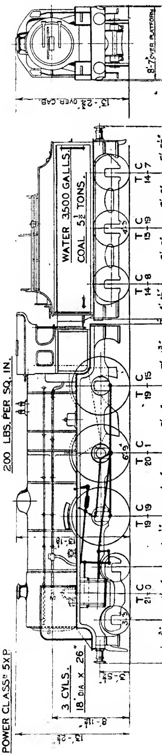
This policy is also dictated by traffic requirements in so far as the reboilering raises the engines from power classification 5X to Class 6. The conversion of 18 of the "Patriot" class engines has been authorised in the first instance, and it is intended that the work shall be completed during 1947.

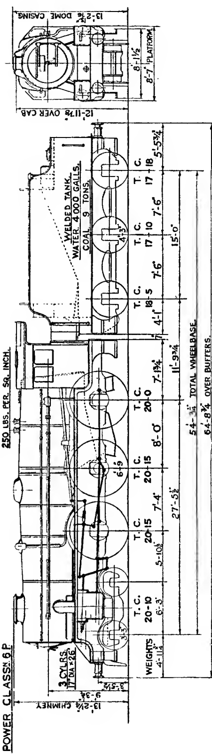
New Details

The opportunity has been taken to renew various details such as the cab, smokebox and saddle, cylinders and the spring suspension, so that the converted engine becomes virtually identical with the two converted "Silver Jubilee" engines Nos. 5735-6, which have already been



" Converted Patriot " class locomotive, No. 5530, *with taper boiler*


POWER CLASS 5XP
200 LBS. PER SQ. IN.
3 CYLS.
18" DIA x 26"
WATER 3500 GALLS.
COAL 5½ TONS.
13'-2¾" OVER CAB.
8'-7⅝" OVER PLATFORM
8'-7⅞" OVER CYLS.
TOTAL WHEELBASE 52'-3¼"
LENGTH OVER BUFFERS 62'-8¼"


POWER CLASS 6P
250 LBS. PER SQ. INCH.
3 CYLRS.
17" DIA x 26"
WELDED TANK.
WATER 4,000 GALLS.
COAL 9 TONS.
13'-2 1/16" DOME CASING
12'-11⅛" OVER CAB
8'-7" PLATFORM
13'-2¼" CHIMNEY
WEIGHTS
54'-3¼" TOTAL WHEELBASE
64'-8¾" OVER BUFFERS

described in the Press. It is interesting to note that the whole conversion has been carried out with an increase in weight of the engine portion of only 1 ton 5 cwt., whilst the power potentialities have been increased out of all proportion to this.

In accordance with the latest policy of the Company, these engines are being provided with rocking grates, self-emptying ashpans and self-cleaning smokeboxes. Tenders of the standard 4,000-gallon type are being provided in place of the earlier pattern of 3,500 gallons capacity.

It will be seen that by the modifications now being carried out these powerful engines, which have rendered from 12 to 16 years of valuable service, but which were becoming obsolescent in relation to more recent designs, are being thoroughly modernised and made suitable for a further period of usefulness.

A comparison of the leading particulars both before and after rebuilding is given herewith :—

Leading particulars	As turned out in 1930-34	As rebuilt 1946-47
Driving wheels, dia.	6 ft. 9 in.	6 ft. 9 in.
Cylinders :	3	3
Diameter ..	18 in.	17 in.
Stroke	26 in.	26 in.
Boiler pressure ..	200 lb./s. in.	250 lb./ sq.in.
Tractive effort at 85 per cent. b.p.	26,520 lb.	29,590 lb.
Heating surface :		
Firebox	183 sq. ft.	195 sq. ft.
Tubes	1,552 ,,	1,667 ,,
Total evaporative	1,735 ,,	1,862 ,,
Superheater ..	365 ,,	348 ,,
Grate area ..	30.5 ,,	31.25 ,,
Weight in working order :	tons cwt.	tons. cwt.
Engine	80 15	82 0
Tender	42 14	53 13

A JOYOUS SNIPPET-RUN

By J. N. Maskelyne, A.I.Loco.E.

THE 24-mile stretch of the G.W.R. between Paddington and Maidenhead is one which I traverse each way daily—sometimes even twice daily. There are a very few trains which are scheduled to do the run non-stop, and for these the time-table allows from 30 to 32 minutes. In the course of six years, I have noted only four runs in which the distance has been covered in less than 30 minutes ; and of these the best was the extraordinary burst of locomotive exhuberance timed on the 5.16 p.m. *ex* Paddington on Tuesday, March 11th, last. Our engine did not back on until about 5.20, and I had no opportunity of seeing what she was.

I had fears lest we should be held still longer before being allowed to depart, because the 5.13 p.m. semi-fast train to Bristol was standing beside us, waiting for an engine. My fears were groundless, however, for we were off at a few seconds before 5.22 p.m. ; and then ensued one of the most exciting "outer-suburban" runs that I have ever experienced.

To begin with, the exit from Paddington was most unusually rapid, and no farther out than Westbourne Park our speed had reached nearly 50 m.p.h. We were up to 60 m.p.h. at Acton, 70 at Southall, 75 at West Drayton, and then, from Langley to Burnham sustained a steady 77 m.p.h. Soon after this, our engine set up a prolonged whistling ; obviously, the Taplow distant-signal was against us, for the driver eventually braked fairly sharply and caused a marked reduction of our hurricane progress. But, fortunately, the road proved to be clear and we managed to keep up a smart pace until we slackened speed to about 30 m.p.h. to take the crossover from Main to Relief, at Maidenhead East signal-box. We came to a stop in Maidenhead station at 5.46 p.m., having covered the 24¼ miles from Paddington in the magic "even time !" Thus, I was given the straight answer to a question which had been frequently in my mind for some years : Was it within the bounds of ordinary running to cover that distance, *start to stop*, in 24 minutes ?

At Maidenhead, I went to see what our engine was, and found 2-cylinder, 4-6-0, No. 2928, *Saint Sebastian*, standing at the head of the train and looking as though she had not been cleaned for at least twelve months !

My three previous "best" runs over this stretch of road have been : Two in the down direction in 28 minutes each, for which 4-6-0 engines No. 7819, *Hinton Manor*, and No. 6869, *Resolven Grange*, respectively, were responsible, and one remarkable up run in 28½ minutes behind, surprisingly enough, 2-6-2 tank engine No. 6144. It is noteworthy that, in all three of these runs, the engines concerned have cylinders 18 in. by 30 in., and 5-ft. 8-in. coupled wheels ; and the maximum speed attained by each engine was in excess of 70 m.p.h. Another interesting point is that all three runs were made during the war years.

No. 2928's brilliant snippet is the first post-war occasion on which I have noted a total time for the trip of less than 30 minutes. And I am afraid I shall have to wait a long while before such another run is recorded ; for, on March 15th, an official order was issued limiting the maximum speed of all trains to 60 m.p.h., owing to the impossibility of overtaking the arrears in track-repairs.

Incidentally, No. 2928 had a train of seven well-filled main-line 8-wheeled coaches ; say, 200-215 tons load. *Her* coupled wheels are 6 ft. 8 in. diameter, but her cylinders, like the others, are 18 in. by 30 in. Her extraordinarily rapid start, therefore, was all the more surprising, and I wonder whether she was starting "cold." Readers who are interested in locomotive technicalities may like to ponder over that one !

All four runs that I have mentioned were exceptional, No. 2928's particularly so ; usually the non-stop trains keep well to scheduled times, and without any apparent difficulty, no matter what the engine may be.

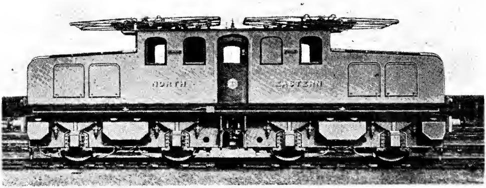


Photo by] [Locomotive Publishing Co.

Fig. 10. *Yet another L.N.E.R. electric locomotive*

*Electric Locomotives for Passenger Hauling—(4)

By "Milli-Amp"

VERY sincere apologies are made for the long break in this series of articles—I am the guilty party and have only one excuse to offer, which happens to be a true one! Pressure of work has compelled me to spend abnormally long hours at my business, with the sad result that not only have I been unable to find sufficient spare time in which to write and draw for these articles, but worse still, suspended for a time all model engineering work.

This has naturally held up my 6701, which means that with the next article the description will have caught up with the state of the model at present. I shall, however, go "all out" to rectify this state of affairs and thus keep the actual construction up ahead of the published details, though I may have to abandon my original plan of making the motors, and resort to ready-made ones. I will, in any case, ensure that sufficient data is given to enable readers to make up their own motors.

Several letters have reached me concerning both the break in the articles and the subject of them. I am pleased to know that at least one other 6701 model is taking shape, and hope to include reports on it when the testing stage has been reached. The builder, Mr. G. F. Robinson of Cleethorpes, has been fortunate in securing a 50-Volt 30-Ampere D.C. generator which he intends using for the power supply. This will prove ideal for the purpose.

Before proceeding to the details of the bogie-stretchers, the photographs included here may prove of interest. Fig. 10 shows the Raven L.N.E.R. electric locomotive, and is the prototype of Mr. Dunn's fine $2\frac{1}{2}$-in. gauge job shown at the M.E. Exhibition last year.

**Continued from Vol.* 95, *page* 587, "*M.E.*," *December* 12, 1946.

Photo by courtesy] [*The Southern Railway*

Fig. 11. *The latest Southern Railway electric locomotive. On show—*

Figs. 11 and 12 should please two of my correspondents, who have asked for photographs of the Southern Railway's latest electric locomotives. The length of this engine is somewhat greater than L.N.E.R. 6701, and in a $3\frac{1}{2}$-in. gauge model would come out to about 3 ft. 6 in. long over buffers—quite a nice size!

Thanks are due to the Southern Railway for supplying the print for Fig. 11, and also a full sheet of outline drawings of the locomotive. I am willing to prepare outline drawings of this or any other locomotive, such as the L.P.T.B. example shown earlier, if readers will let me know. They could be dimensioned for either $2\frac{1}{2}$-in. or $3\frac{1}{2}$-in. gauge, whichever is the more popular.

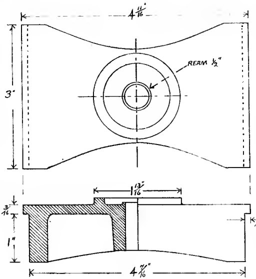


Fig. 13. Bogie stretcher details

Bogie-Stretchers

Full details of the bogie-stretcher castings are given in Fig. 13. Machining has been kept to a minimum and is easily carried out. The castings are provided with chucking-spigots, enabling them to be chucked in the self-centring chuck for drilling and reaming. A stub mandrel with a square shoulder should then be made up, a tightish fit for the reamed hole. With the castings mounted on this, the remains of the chucking-piece can be machined off and the raised rubbing-face machined.

If preferred, all the machining can be done in the four-jaw chuck at one setting, with the exception of the underside of the boss for the bogie-pin, which can be done by slacking off only two jaws of the chuck and reversing the casting. Care must be taken to set up the casting to run true—this can be checked from the chucking-spigot (before it is cut off) or from the circular rubbing-face.

The rebates for the frames can be machined by an end-mill or fly-cutter, with the casting packed up to the correct height on the cross-slide, or mounted on an angle-plate on the vertical slide. Care should be taken to ensure that these faces are set up so that when machined they come out dead square and parallel all ways.

The holes for attaching the frames are not shown on the drawing, as they can most easily be spotted through from the frames themselves, the stretchers being clamped to them for this purpose. The holes are drilled for tapping 5-B.A. and countersunk screws used for fixing, to allow the sand-boxes to be fitted later.

(To be continued)

Photo by] [*Locomotive Publishing Co.*

Fig. 12.—And at work!

PETROL ENGINE TOPICS

* A 15-c.c. FOUR-CYLINDER ENGINE

By Edgar T. Westbury

THE flywheel should be made from a mild steel blank, if available, but as many constructors may not be able to obtain this, a casting in iron or gunmetal will be suitable. Personally, I favour gunmetal or bronze of fairly good quality for flywheels, as its specific gravity is a little higher than iron or steel, and therefore its momentum is greater for a flywheel of given dimensions. Its appearance, however, may be objected to, though this may be improved by dull plating, if desired. Whatever material is used for the flywheel, it should be machined all over, with due care to keep all parts concentric with each other (Fig. 14).

Recommended procedure for machining the flywheel is as follows: First chuck the blank or casting with the pulley end outwards, and rough turn as much of the outside as is accessible at this setting, including the groove, leaving not more than about 1/32 in. for finishing. If a casting is used, it will be possible to grip it by the inside of the rim, so that the whole of the outer surface can be turned; but if working from a blank, only a part of this surface is accessible. Next, reverse the work, holding it as truly as possible, to turn the rest of the surface, including the recess and the back face of the rim, which may be finished to size right away, also rough turn any part of the rim not accessible at the previous setting; then centre, drill and taper bore the central boss, all at the same setting. A reamer may be used to finish the bore, if one is available of approximately the specified taper, but should only be applied after boring to within one or two thousandths of an inch of finished size. As already mentioned, it is advisable to finish the flywheel bore first, and match the taper of the crankshaft to it.

The flywheel is secured to the crankshaft, or on a specially-made tapered mandrel (preferably the latter), which is run between centres for finish-turning the exterior surface. With due care, this method should produce a flywheel which is perfectly true all over. It is surprising how many wobbly flywheels one encounters, but there is no excuse whatever for this state of affairs—even the old, old story that the lathe "won't turn true" isn't good enough in this case!

Balance

When steel or other bar stock material is used, the flywheel should be perfectly balanced when machined all over concentrically, but this does not necessarily apply in the case of a casting, as the material may not be perfectly homogeneous, and may even have concealed blow holes below the surface. It is good policy, in this event, to test the static balance of the flywheel by rolling its mandrel on knife-edges, and if an error is found, correct it by drilling the inner side of the rim on the heavy side, or by running a little soft solder inside the rim on the light side.

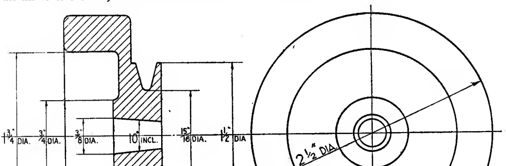


Fig. 14. *Flywheel*

*Continued from page 416, "M.E.," April 3, 1947.

The latter is perhaps the best way, as quite a thin film of solder, not sufficient to affect appearance much, is usually adequate, and it may be scraped away to obtain fine adjustment of balance.

The static balance of the crankshaft itself may be tested out and similarly corrected if necessary, but static balance, in this case, is not sufficient. Owing to the length of the crankshaft, it is possible that serious errors in dynamic balance

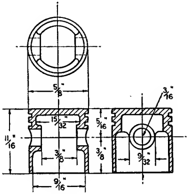


Fig. 15. *Pistons (4 off)*

may exist although static balance is perfect, but this may be avoided to a great extent by ensuring that the distribution of mass is equal at the two ends of the shaft. In other words, any parts which might conceivably be out of balance, such as the end webs, the diagonal centre webs, and the crankpins themselves, should match, end for end, in respect of dimensional uniformity.

Balance is, perhaps, more important on an engine of this type than on the usual single or twin, because it is really capable of something like perfect balance if due care is taken, and the sweet running and absence of vibration of a well-balanced four-cylinder is one of its most impressive characteristics.

For the benefit of those who have not studied balancing problems, it may be mentioned that although the reciprocating weight of a piston may be balanced by that of another piston of equal weight moving in opposite phase—as in a twin cylinder engine with opposed cranks—true dynamic balance can only be obtained when the pistons move in exactly in the same plane—as in the opposed piston engine, or an opposed twin with no "offset." But when the pistons are side by side, their motion produces a "couple," tending to rock the shaft about a point between the crank throws; and the effect of this can be, and often is, much worse than that produced by the unbalanced reciprocating weight.

In the normal type of four-cylinder engine, the rocking couple is cancelled out by opposing one half of the mechanical system against the other half; this is known as "mirror" balance, because one half is the counterpart of the other as seen by reflection in a mirror. Rocking couples are then produced in each half of the crankshaft, but they are equal and opposite, and assuming reasonable structural rigidity in the engine, produce no external effects. This applies not only to four, but also six, eight or more cylinders when arranged side by side in the same plane. If, however, the weights of the opposed reciprocating or rotating pairs at the two ends of the engine are not equal, they do not cancel exactly, and vibration or rough running will result.

Pistons

These are illustrated in Fig. 15, and it will be seen that they are intended to be made from castings in iron or aluminium, and to be fitted with rings. At the moment however, it is not certain whether piston rings of the size required can be obtained, and although it is possible for the amateur to produce rings which will work satisfactorily, this is an extremely delicate job which most constructors will probably wish to avoid if possible. Plain pistons machined from cast iron, and fitted to the finest possible clearance in the cylinders, will give quite good results, and unlike two-stroke engine pistons, the presence of the empty ring grooves will do no harm; in fact, they are advantageous, as they will help to preserve an oil seal. The procedure for machining pistons from the solid has been described several times, in connection with the construction of two-stroke engines, and need not be repeated here. It is desirable to make the pistons as light as possible, and each should be exactly the same weight.

If there is any variation in the diameter of the cylinder liner bores, selective fitting of the

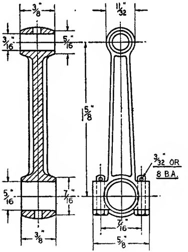


Fig. 16. *Connecting-rods (4 off)*

pistons is necessary, and each one should be marked to show in which cylinder it belongs. By the way, it is usual to number the cylinders from the timing end, but either way will do, so long as it is decided upon definitely, and adhered to. Aluminium pistons will not be entirely satisfactory unless fitted with rings, as they call for greater clearance to allow for

expansion, and will therefore fail to produce a good compression seal when starting up from cold. The advantages of reduced weight and improved heat conductivity of aluminium pistons are not likely to make much difference to performance in so small an engine.

Connecting Rods (Fig. 16)

Cast bronze rods are the simplest form of construction, and give quite satisfactory results in small engines for speeds up to 7 or 8 thousand r.p.m. Duralumin or steel rods, machined from the solid, may be preferred by the more fastidious worker, but show little, if any, advantages in practice, and in the latter case, bronze or anti-friction metal linings would have to be fitted in both big and little ends, which would consequently have to be enlarged in diameter, increasing bulk and weight.

The four rods should be identical in the length between the eye centres, and also uniform in weight when finished. If castings with solid big-end eyes are used, there should be sufficient metal to allow for splitting and cleaning up the faces of the bearing, after rough drilling the eye and also the bolt holes, and marking on the sides of the bottom lugs, to number the rods and show positions for assembly. For splitting the eyes,

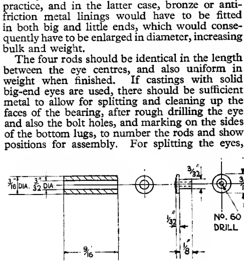


Fig. 17. Gudgeon pins (4 off)

a circular saw running in the lathe is advised, the rods being held in the tool post, with packing above and below, and with the centre line exactly parallel with the lathe axis. This will leave truly finished surfaces, which require hardly any further treatment, beyond a slight rub on a smooth file to remove burrs. The lower half of the bearing has the holes opened out to clearance size for the fixing screws, the upper half being tapped, after which temporary screws are fitted, and the rest of the work on the rods is the same as that for the more usual solid-eye type of rod.

It is a good policy to bore the little end of each rod first, holding the rod in the four-jaw chuck, with the boss central, and the centre line of the rod parallel with the chuck face. The end of the boss can be faced at this setting, and it may also be found advisable to skim up the tapered outer surface as far as it can be reached. Similar treatment may be applied to the other end of each boss, by mounting the rod on a stub mandrel. Next make a locating pin to fit the bore of the eye, and mount this squarely on a steel block which can be clamped in the groove of the four-jaw chuck, in place of one of the jaws. By setting the eye of the rod on this pin, at the required distance from the chuck centre, and using the other three jaws to centralise the big-end, the parallelism of the two eyes is definitely assured. When set for the first rod, the rod is fixed in position for the other three, which will then ensure that the length of the rods between eye centres is exactly the same.

If machined in this way, there should be no question about the correct alignment of the rods when assembled, but in order to check up on any possible errors, the rods should all be assembled on the crankpins, and the crankshaft temporarily assembled in its bearing endplates. The position

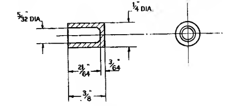


Fig. 18. Valve tappets (8 off)

of the rods can then be seen from the tops of the cylinders, and it will be instantly apparent if they are out of centre; this should be checked at both ends of the stroke, and correction made, if necessary, not by bending the rods, but by machining away the face of the little end boss. It is better to allow plenty of side play between the little end boss and the piston bosses than to risk binding on either side; but the dimensions shown on the drawings do not allow for definite end play, because of the desirability of obtaining maximum permissible bearing length in the little ends.

Gudgeon Pins (Fig. 17)

These may be made of mild steel and case-hardened, or of high-tensile steel, without subsequent hardening. They are drilled through the centre, and fitted with soft brass or aluminium end pads in the usual way.

Valve Tappets (Fig. 18)

These also are best made of mild steel and

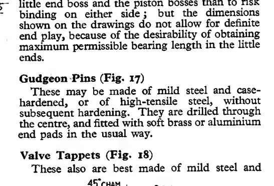


Fig. 19. Valves, with adjusting and locking nuts (8 off)

case-hardened. They consist of light thimbles, eight in number, which should be finished to a smooth sliding fit in their guides. In order to lighten them as much as possible, they are drilled in the centre, and the end of the hole should be finished with a flat-ended drill or D-bit, chamfered or rounded at the corners. The bottom

end face should be finished dead smooth and true, and hardening is essential. If desired, two or three fine oil grooves may be turned in the outside of the tappet to distribute oil and check oil creeping.

It has not been thought necessary to bush the tappet guides, as this would call for a somewhat awkward boring operation, the diameter of the bush seating being larger than the entry passage through the valve port. The side thrust on the guides is not heavy, and no great wear and tear at this point is expected; but bronze bushes may be fitted if the constructor is prepared to go to the extra trouble entailed in doing so.

Valves (Fig. 19)

Although it is not necessary to use special valve steel for making these, something better than ordinary mild steel is desirable. Good results have been obtained with 3 per cent. nickel steel, and also with stainless steel of the "free cutting" grade; high-tensile stainless and other special steels are generally very difficult to machine, and are best avoided for delicate components which call for accuracy and good finish.

The valves may be turned at one setting and parted off, the use of a running-down tool being helpful for ensuring a smooth, parallel finish on the shank. If only the ordinary tools are available, however, it is advisable first to turn down the extreme end of the shank to finished size, chamfer off the end, and support it with a hollow centre while turning the rest of the shank. A slight radius should be left under the head, and the seating face should be turned by setting over the top slide to 45 degrees—not by the use of a bevel forming tool, which is very liable to leave waves in the finished surface, and thereby prevent the valve from seating properly.

It is important that the shank of the valve should fit the guide closely, so as to avoid the possibility of air leakage, but it must on no account be tight or sticky to cause sluggish or erratic action of the valve under working conditions.

Owing to the small diameter of the valve stem, the problem of retaining the spring is a rather delicate one, as the usual methods were impracticable, and it has been decided to use screwed valve stems, with lock nuts, as this method has proved highly satisfactory on the "Kinglet" and other small engines. This also provides an extremely simple method of tappet adjustment. The upper nut is shouldered to centre the spring, and the lower one is a standard thin lock nut; both nuts should be case-hardened, and it will be noted that the thrust of the tappet is taken on the face of the nut, not on the end of the valve stem. A slot should be cut across the valve head, so that a screwdriver can be used to hold the valve while adjusting and locking up the nuts.

(To be continued)

Chemical Colouring of Metals

By G. Woodin

THE following are useful formulae for the chemical colouring of various metals, and have proved most useful in the making of model ships fittings, etc.

Imitation Silvering of Brass, Copper, Iron or Steel

Place a globule of mercury, about the size of a pea in a mortar, add two teaspoonfuls of powdered chalk and grind for half-an-hour until the chalk has acquired a grey colour. Moisten the end of a soft rag with methylated spirit, then take on it a small quantity of the powder. Rub this over clean surface of article to be silvered. In a few seconds a thin shimmery silver film will form on the surface which can be thickened by a further application of powder.

Dead Black Colouring of Brass or Copper

Immerse article in a liquid of 1 oz. of copper nitrate and 3 oz. of water. A small quantity of silver nitrate dissolved in this solution is said to improve colouring, but is not essential.

Black Colouring of Silver

Immerse in a solution of sodium sulphide.

Black Colouring of Zinc

Immerse in solution of antimony chloride.

Blue-Black Colouring of Iron

Immerse in a solution of photographic hypo. An addition of a little lead acetate or nitrate to the solution inproves the colouring.

Slightly Shiny Black Surface for Copper

Copper will acquire a slightly shiny black surface when immersed in a solution of ammonium sulphite 1 oz. and water 4 oz. When brass is immersed in this liquid it will take on a steely-grey colouring.

To Tint Aluminium Blue

Dip metal in a hot, medium strong solution of caustic soda (sodium hydroxide) for a few seconds then rinse in warm water and dip in a hot solution of an aniline dye. The metal will then be permanently tinted.

Dulled Aluminium

Dip metal in hot, medium strong solution of caustic soda.

Golden Colouring of Brass

Immerse in a very dilute solution of ammonium or sodium sulphide.

Red Colouring of Copper

Immerse as above. As strength of the solution varies so can almost any red, yellow, brown or black colour be obtained on the metal.

Tinting Brass

Brass can be given tints varying from pale gold to pink and pale blue by immersing in a solution of $\frac{1}{2}$ oz. each of lead acetate and hypo to 1 pint of water.

Greying Iron

Iron can be given a grey colour by boiling for half-an-hour in a weak solution of iron phosphate.

The Model Tug Boat "Falcon"

By J. E. Jane

As a complete newcomer to the realms of Model Engineering, I must confess that it was chiefly enthusiasm which enabled me to complete this first attempt at model power boat building.

The sight of model boats on our local pond during my usual Sunday morning "jaunts," has many times filled me with the desire to try my hand at a spot of "Wood cutting" or "Solder Bashing." But the thoughts of the hundreds of necessary "bits and pieces" required, somewhat damped my spirit, and the perusal through a couple of borrowed books on the subject of sail plan, C.L.R., C.G., rigging, displacement, etc., just about flattened me. However, a chance meeting with an acquaintance who had a reputation for being an expert on such matters, decided me to venture. Subjected to a considerable amount of advice from him, I decided that, as I was more "acquainted" with "pliers and metal" than I was with wood, something of the "power" type would be more to my liking; and preferable to sails.

Another "look-see" through the borrowed books, decided me upon the type: A Tug Boat. The subject of design etc., proved rather difficult, as I was unable to obtain drawings. But as I had, at one time, managed to produce a few recognisable artistic drawings of ships, I decided to try my hand at producing my own design. A prowl or two round the harbours, fortified with pencil and paper, provided me with a few details as to size, shape, and dimensions of hull, funnels, mast, deckhouses, and equipment. A visit to the ironmongers, provided me with the necessary sheet metal, and a good "scrounge" in the junk box resulted in bringing to light an odd assortment of brass, copper, and pieces for the small parts.

Having assigned all this to a heap on the workshop bench, I then repaired to the fireside table, and provided with pencil and rule, tackled the subject of scale, length, depth, stability, etc. A few weeks of this (during which time I was almost reduced to a state of despair), eventually produced, using ½ in. to 1 ft., something with the following dimensions:

Hull.—Length overall, 35 in.; depth, main deck to keel, 6 in.; width, 7 in.

Details of construction are as follows:—

Sheet tin, aluminium, and brass, were used throughout with the exception of the fender, life boat, blocks, and bollards, which were of wood.

The hull was built in three sections: bow portion, centre, and stern portion, each section set out on flat pieces of tin, cut to the required lines, and bent to shape. The three portions were then soft soldered together, the joints being reinforced with strips of tin. A brass keel, made from ¼ square, was then riveted, and sweated on to the bottom. This extended aft to form the seating for the stern post.

The fore, and quarter decks were then cut from tin and soldered into position, ¾ in. below to the upper edge, to allow for bulwarks.

The fender was steamed to shape, and fastened to the hull from inside with c.s.k. wood screws, through holes drilled for the purpose.

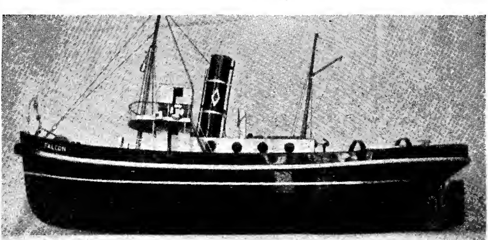
The stern-post—cut separately, and fitted on.

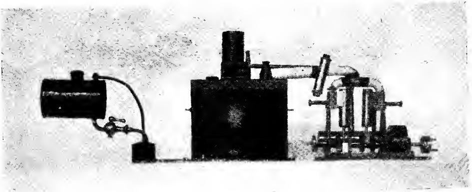
Superstructure: Deckhouses, casing, funnel, bridge, made from tin, and bolted with 6 B.A. bolts to a detachable main deck.

The funnel was rolled from flat tin and capped with brass wire.

Ventilators: Beaten out from flat brass to form cowels, and soldered to brass tubes.

Ports on casing were drilled out, and fitted with light brass washers ⅜ in. diameter and burred





over. Bridge rails are of thin steel wire, the capping rail of oval wire, and the stanchions were fashioned from 1 in. panel pins.

Companion ways, were built up from tin and wire.

Masts. Made from $\frac{3}{4}$ square, rolled out.

Port, and starboard, and mast head lights. Made from tin with cellophane inserted to represent glass.

Anchor winch: Built from an old camera spool, and clock gears.

Anchor davit: $\frac{1}{8}$ dia. bar.

Anchor: $\frac{1}{8}$ dia. bar, beaten out to form the points (anchors are of the stockless type).

Life boat: This was carved out from a piece of white pine, with one pair of oars, and a boat hook made from beech.

The deck irons were made from thin sheet iron fitted into position, and bolted.

Colour Scheme

Hull, painted black to water line. The under water position is painted red. A white line extends around the hull at the water line. The fender is also painted white. The inside of hull had three coats of aluminium. The deck is painted dark green and lined.

Superstructure is white; funnel red, with black top and white bands.

Wheel house: Lined with walnut and stained.

Power Unit

Engine:—As my knowledge of steam power is very limited, and only extended to the point of knowing that piston was "pushed" back and fore, the possibility of one of the slide valve, or compound type, was completely out of the question. This was apart from the fact that I had not the necessary equipment at my disposal for construction. Therefore, after another good "look-see" amongst the books, plus some more advice from my friend, I decided upon one of the oscillating type. Details of which are as follows:

Two cylinders were cut from brass tubing $\frac{7}{16}$ in. inside dia., $1\frac{1}{2}$ in. long. Pistons: from steel rods, and fitted to cylinders. Piston rods: $\frac{1}{8}$ in. dia. mild steel cut to required length and sweated to pistons.

Big ends: Are of brass, cut in two sections, drilled through, and bolted with 6 B.A. nuts and bolts.

Crank: 3/16 in. dia. steel rod, with steel webs.

Engine supports of 20 g. sheet iron.

Flywheel of steel, 2 in. dia. $\times$ $\frac{5}{8}$ in. wide.

Universal driving wheel of brass.

Engine bed of brass curtain rails (angle type).

Displacement lubricator from $\frac{3}{8}$ in. brass tubing.

Steam pipe: $\frac{1}{8}$ in. tube. Exhaust: $\frac{1}{4}$ in. tubing

A form of condenser is fashioned from an old 20 mm. parallel cartridge case.

Boiler is of copper, 5 in. $\times$ 3 in. with water tubes of $\frac{1}{4}$ in. dia. The end plates were sweated in position. A $\frac{1}{8}$ in. dia. brass stay runs through from end to end. Both ends protrude through end plates to form supports for boiler casing.

Boiler casing is of 20 g. sheet iron. Drilled with $\frac{1}{4}$ in. holes for ventilation.

Burners are of the "Chicken Feed" type, the spirit tank being an old paint tin 2 in. $\times$ 3 in. and the reservoir, a shaving stick case. The burner itself is of the box type, built up from sheet brass to form two separate boxes, the inner one being the actual burner, and the outer one forming an overflow catchment.

The tubing is of $\frac{1}{4}$ in. brass through burner, and $\frac{1}{8}$ in. copper, from tank to reservoir.

The whole unit was completed and tested before work on the boat had commenced.

A "bench test" resulted in the engine running for approximately three quarters of an hour at about 800 to 1,000 r.p.m. with the boiler three quarters full, and the tank two thirds full.

The weight of the unit is $8\frac{1}{2}$ lb. "loaded," and the complete boat weighs 18 lb.

As to the making of the boat; difficulties again proved to be numerous, but progress was eventually made.

The bath room proved indispensable for my periodical tests. The subject of the propeller was a headache, but a "built-up" one of the four-bladed type was eventually decided upon, with a medium pitch. Much to my delight, this worked first time, and caused the boat to push its nose up against the "taps," and stay there. This indicated an early trial on our local pond. So bright and early one Sunday morning I tucked the boat under my arm, and stealthily made my way in the direction of the afore-mentioned sheet of water, fully prepared to either gnash my teeth or glow with pleasure.

(*Continued on page* 496)

THE SHIP MODEL SOCIETIES

By "Jason"

THE Sheffield Ship Model Society held a very successful Easter Week Exhibition. There was an open award, to be won outright, for the best ship model in the exhibition, irrespective of type or class. I hear that some entries were sent in from the London Societies. Nevertheless, from what I know of Sheffield, work there was bound to be a tough tussle for that trophy.

The society meets first Thursday in the month at Howard Hotel, Howard Street, Sheffield 1. Write to M. Maltby for the new syllabus. Address: 32, Abbeydale Park Crescent, Totley Rise, Sheffield.

Wembley

Not every modeller can get "sea" experience so the talk by Mr. L. E. Braddick on the advantage of "Practical Seamanship as Applied to Period Craft," was well received. Mr. Braddick is a keen yachtsman and would never be guilty of an "Irishman's lead," which is another way of saying that ropes should not chafe over each other or on some foreign surface. The question was once raised which type of ship had most ropes per mast; Commonwealth, Napoleonic, Western Ocean Packet, Clipper, or Windjammer? I think I'll keep the answer back as this might offer an amusing 10 minutes at your next meeting. Which reminds me that the Wembley syllabus is now ready. Write to Alec Purves, 65, Eton Avenue, Wembley, for your copy. April 1st meeting was about the "Early Boats of N.W. Europe," by "Jason." May 6th, is on "Early Egyptian Ships," by the chairman of the South West London Society, Mr. V. O. Lawson. Make a very special note of June 3rd to hear Mr. Draper on "Miniature and General Modelling Hints." Meets first Tuesday each month in St. Andrews Hall (side door) Ealing Road, Wembley. It is quite close to Wembley Station (L.M.S.).

Ilford

Mr. Chapman tells me they have already had informal meetings of the former members. They are looking forward to their first open meeting. Write him for date and venue. R. A. Chapman, 218, Old Ford Road, London, E.C.

Brixham Trawler

Mr. John Lang, of Street, Somerset, is anxious to build a timbered and planked model of a Brixham Trawler. He wants to follow as closely as possible the actual framing and timbering practices. He asks where he can get such details. Well, as far as I know such details were never published. Each yard had its own tricks, even in the same locality. Perhaps some other reader of these notes has tackled this job before. If so, I'd be glad to hear from him. Several years ago *Picture Post* published an illustrated article on the building of M.F.V.'s for the Admiralty, but this would not help very much, because it is a much bigger craft with a cruiser stern, whereas the special feature of the Brixham Trawler is the overhanging long counter. The general principles of framing are the same for all wooden ships during the last 200 years. The differences arise in section of frames, futtocks, keel, kelson and deadwoods, spacing varies too. The shape of the stern calls for special treatment.

Mill Hill

Master David Marshall (15), sends me a photograph of his H.M.S. *Victory*, (as at Trafalgar). This is an extremely fine attempt for a youngster. It is unusual to find a youngster "staying the course" for such an intricate model. Many "oldsters" give up long before the end. Fine work, David! But I'll criticise your next model. Nothing but praise is due for your present two-year job.

South West London

This society is now well off the post-war mark. They meet formally on the third Wednesday each month, at 7.30 p.m. Note well the new meeting place. Balham Labour Club, Balham Park Road (by Balham Station). In addition, an informal meeting is also held at a member's house (by rota). At a recent meeting I overheard of several fine tips. First, sharpen up the ends of old and unusable hack-saws. They make excellent chisels. The second, one is for "Period riggers." Buy a pair of arterial forceps which automatically keep a grip on a "rope." The forceps may then be left hanging on to the rope until required. A simple pressure and the forceps release their grip. Buy your forceps from the surgical instrument makers. Very long thin pointed tweezers are also invaluable for the "period" or windjammer rigger. Wax or glue your rope ends for ease in reeving off. Try Messrs. Downs Bros. Ltd., of Thomas St., Southwark, for some surgical instruments. Get in touch with A. L. Tucker, 23, Fernley Road, South Norwood, S.E.25.

Weymouth Away

I hear from an old friend, and incidentally, a former Wembley member, Mr. S. G. Harmer, of 10, Frederick Place, Weymouth, Dorset, that he has launched a ship model society in that place. Mr. Harmer talks about a club workshop. We tried it in Liverpool but it did not succeed. Shipmodellers are different to the engineers for many of their tools are heavy and expensive, whereas ours can be stored in a small attache case. Dorset men should contact Mr. Harmer at the above address.

North London

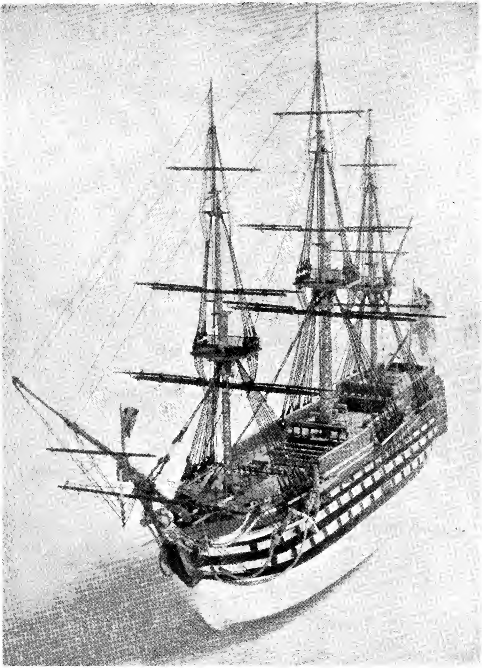
Keeps busy. Meets first Friday in each month in Union Chapel Club House, 19, Compton Terrace, Highbury, N.1. On May 3rd, "Jason" discusses "Markets and Materials for Modellers." Write to M. E. Moon, 53, Freegrove Road, Holloway, N.7, for syllabus and invitation to visit.

Birmingham

Modellers should contact A. E. Field, 26, Kinnerley Street, Walsall, Staffs, for latest information and details of next meeting.

Liverpool

Those who are keen miniaturists should contact Mr. K. Lewis, 20, Morecroft Road, Rock Ferry, Birkenhead.

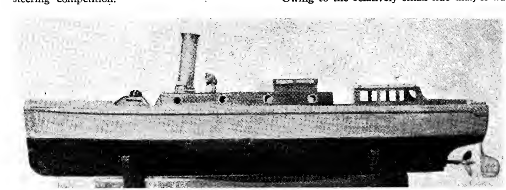


Master David Marshall's model of H.M.S. "Victory"

A Model Picket Boat

By S. Farley

HEREWITH a brief description of the Picket Boat "Sheila," with which I had the good fortune in the recent competitions, held by the Portsmouth Model Engineering Society, to win the "Grant Dalton" Shield, in the 50-yds. steering and nomination event, also the "Lane Cup," in the 175-yds. steering competition.



As can be seen by the photograph, it is not a prototype model. The hull was never intended for a picket boat; the idea was to build a good stiff seaworthy hull, capable of withstanding the rough weather and frequent skirmishes with sailing craft, so frequently experienced on the Canoe Lake.

The dimensions are: 4-ft. length, 10-in. beam, $4\frac{1}{2}$-in. draught.

Keel is oak with ash ribs and is planked with trellis laths. I had intended using mahogany but was too lazy to saw it up. Being disappointed with the finish through using the laths it was cleaned up to obtain the best finish possible, then covered with layer upon layer of brown and newspaper, each successive layer being rubbed down with sandpaper, the final result being a light, clean, and very strong hull.

It is now about nine years old, and has received no attention, except for a yearly coat of paint, and has given no trouble whatever. As stated before, I am very lazy and careless, and it is invariably parked in its locker after use, complete with bilge water, oil, etc. [A practice we do not recommend.—Ed.]

It was originally fitted with a flash boiler as an experiment, but this was replaced with a steel centre-flue boiler. This was discarded after a season's running, owing to its short steaming capacity, which was about 12 min. with one filling. The feed pump was removed from the engine when the flash boiler was rejected.

The present plant consists of a copper centre-flue boiler, 5 in. dia., 10 in. long × 16 g., with a 2 in. flue with seven $\frac{3}{8}$ in. cross tubes.

Owing to the relatively small flue dia., it was found on hydraulic test, the ends tended to bulge, so two $\frac{3}{16}$-in. Monel metal stays were fitted, it was then tested to 200 lb. per sq. in. hydraulic and 100 lb. sq. in. steam, working pressure 50 lb. per sq. in.

The engine was built from a set of castings supplied by Stuart Turner's, it is a No. 10, $\frac{3}{4}$-in. bore × $\frac{3}{4}$-in. stroke. It has proved a wonderful little engine considering the abuse it has had to put up with.

It was part of the flash steam plant, and during the experimental stages it ruined three crankshafts, numerous pump gears, and was rebored three times, the bore being now approximately $\frac{13}{16}$ in. As the steaming capacity of the present boiler is now approximately 40 mins., no feed pump has been fitted, as I find this quite sufficient for one session.

The blowlamp has proved a very reliable job. It is fitted with an adjustable nipple. The burner consists of five coils of $\frac{3}{16}$-in. copper tube on a $1\frac{1}{4}$-in. steel flame tube. The container is copper 3 in. dia. × 4 in. long × 16 g.

The whole unit is mounted on a steel framework which is secured in the hull by two screws, allowing the whole unit to be removed in a matter of seconds.

The Model Tug Boat "Falcon"

(*Continued from page* 493)

So much for my precautions. By the time I had arrived at the water side, I resembled the "Pied Piper of Hamelin."

However, steam was raised in five minutes, and with a "do or die" feeling I placed the boat in the water. My patience was rewarded, because within a minute it was well on its way across the pond. Points were noted :

Stability could have been a little better, as she was seen to be inclined to roll a little with a gust or two of wind. The top speed appeared to be about $2\frac{1}{2}$ knots. Her course seemed to be true enough with the rudder set at zero, for about 30 yards, after which she was inclined to veer off on a circular course. This, I think, was due to wind.

QUERIES and REPLIES

Enquiries from readers, either on technical matters directly connected with model engineering, or referring to supplies or trade services, are dealt with in this department. Each letter must be accompanied by a stamped, addressed envelope, and addressed "Queries and Service," THE MODEL ENGINEER, 23, Great Queen Street, London, W.C.2.

Queries of a practical character, within the scope of this journal, and capable of being dealt with in a brief reply, will be answered free of charge.

More involved technical queries, requiring special investigation or research, will be dealt with according to their general interest to readers, possibly by a short explanatory article in an early issue. In some cases, the letters may be published, inviting the assistance of other readers.

Where the technical information required involves the services of a specialist, or outside consultant, a fee may be charged depending upon the time and trouble involved. The amount estimated will be quoted before dealing with the query.

Only one general subject can be dealt with in a single query; but subdivision of its details into not more than five separate questions is permissible. In no case can purely hypothetical queries, such as examination questions, be considered as within the scope of this service.

No. 8022.—The "M.E." Vertical Enlarger.

A. W. (`tretford)

Q.—In the description of THE MODEL ENGINEER enlarger, it is stated that any lens of 2½ in. to 3½ in. focal length may be fitted. I accordingly bought a 3-in. lens of a well-known make, and found that my maximum enlargement was about four diameters; hardly sufficient for 35-mm. film.

From a table of enlargements, it was apparent that the distance from the lens to the negative must be capable of being reduced to 3¼ in. to give a magnification of 10 or 12 diameters. With the enlarger as designed, this minimum distance is about 4 in., and it is therefore necessary to cut off a total of ¾ in. from the parts between the lens and the negative, incidentally washing out the neat little coloured filter which was so conveniently housed inside the enlarger.

R.—We are unable to understand why you have had to shorten the draw-tube of THE MODEL ENGINEER enlarger, as this has been used with lenses of shorter focal length than you specify, without altering the design. It may be, however, that in the particular type of lens you are using, the focal centre is well in front of the back cell or mount, in which case the lens would have to be mounted closer to the stage than usual; but we should not expect that this difference would be sufficient to put the internal shutter out of action.

No. 8025.—Carburettor for Four-cylinder Engine.

L. O. G. (Croydon)

Q.—I am building a four-cylinder, side-valve engine of 40 c.c. total capacity. Most of the work has been completed, and I now wish to start on the carburettor, but I do not know how to design one, as I have had no previous experience in model petrol engine construction.

I require the engine to rev. very slowly at times, as it is for a ¼ in. scale car; the carburettor should also, if possible, be kept to this scale.

Could you, then, please give me some idea of the size of the choke tube, jets and float, etc.

R.—We are of the opinion that you are attempting a very ambitious project in building a four-cylinder engine without previous experience in petrol engine construction. It is a fairly sound rule in carburettor design that the effective bore diameter of the choke tube should be from one-fifth to one-fourth that of the engine cylinder. Jet sizes can only be found by experiment, which is much facilitated by using a needle-controlled variable jet. Floats may be made more or less to scale, but generally speaking, they have not been found reliable if made less than about ¾ in. diameter.

Suitable carburettor designs for your purpose are the "Atom" Type R, the "Kiwi," and the "Apex," detailed blueprints of which may be obtained from our Publishing Dept., price 2s. 9d. each, post free.

No. 8026.—The "Kestrel" 5-c.c. Petrol Engine.

H. W. (Cranbrook)

Q.—On referring to the plan of the 5-c.c. "Kestrel" engine, I note the $\frac{1}{16}$-in. Desaxe is shown on the plan-view of the engine on the leading edge of the piston, while on the plan of the cylinder it is shown on the trailing edge of the piston. Perhaps you will kindly let me know which is correct.

I have been unable to obtain piston-rings for this engine, so I am hoping you may be able to give me the machining dimensions of suitable rings, so that I can make them myself. I contemplate putting this engine in a model car or boat; I have not yet decided which, so perhaps you would let me know what size and weight of flywheel you suggest would give the best results for either or both of the above.

R.—We do not understand what is meant by the terms "leading edge" and "trailing edge" of the piston, but the offset of the cylinder is in any case towards the direction of rotation; that is to say, away from the transfer port, and towards the exhaust port.

We regret that we cannot assist you in obtaining piston-rings for this engine, but a plain cast-iron piston, fitted to a very fine clearance, gives very satisfactory results, and is practically universal in small engines nowadays. A flywheel of about 2½ in. dia. by 5/9 in. wide on the face, and having a rim ⅜ in. deep in radial measurement, will suit this engine.

No. 8015.—Drilling Machine Details.
W. A. (Aberdeen)

Q.—Would you please explain a small matter concerning THE MODEL ENGINEER sensitive drilling machine. If the vee pulley is fixed to the drill-shaft to transmit the rotary drive, how does the shaft slide through the vee pulley when the feed-lever is lowered?

R.—The spindle of THE MODEL ENGINEER drilling machine is driven from the pulley through what is known as a "feather"-key, a common arrangement in machines of this type. It will be seen that the spindle has a keyway running practically the full length; the pulley has an internal keyway, but very slightly narrower in width, so that the key fits it tightly, but is free to slide in the spindle keyway. The spindle can therefore move freely endwise, while the drive is being transmitted by the key fixed to the pulley.

No. 8020.—Carburettor for 30-c.c. Engine.
W. E. C. (Wembley Park)

Q.—I am anxious to make a carburettor for a 30-c.c. petrol engine, and shall be glad to know if you have available any instructions or blueprints of a suitable design?

If possible, I should like it to be applicable to both a four- and a two-stroke engine.

R.—The carburettor best suited to your purpose is the "Atom" Type R, which is suitable for use on all types of model petrol engines from 15 c.c. upwards. Fully-detailed blueprints of this carburettor may be obtained from our Publishing Dept., price 2s. 9d. post free, but it should be noted that the body dimensions on this print refer to a carburettor suited to 15-c.c. engines. An enlarged body, having a bore of $\frac{1}{2}$ in. at the discharge end and $\frac{3}{8}$ in. at the choke tube, should be used to obtain full power from a high-performance 30-c.c. engine. Castings for this carburettor, including the special enlarged body, may be obtained from Mr. W. H. Haselgrove, 1, Queensway, Petts Wood, Kent.

No. 8019.—Electric Motor Design.
B.P. (Southgate)

Q.—I have been studying your publication, "Small Electric Motor Construction," by J. Gordon Hall, and find the tables very useful.

Can you please tell me how to arrive at winding formulae for various speeds at a given voltage? For the purpose in mind, the speed is most important, as the motor has to drive a light timing device, and the use of a resistance to pull the speed down is not a good way of obtaining the desired end. One version of the motor will be run off a 6, 8 or 12-volt car-type accumulator, and another type would require a small motor wound for either 110-volt or 220-volt supply mains.

I have collected a lot of formulae for windings, but cannot locate any for change of speed.

R.—It is not quite clear whether you are concerned with winding motors for a given speed at constant voltage, or for *regulating* speed at constant voltage. In the former case, speed may be varied by adjusting the balance of field and armature windings, so that the amount of current flowing in each produces the required characteristics of torque and speed. Generally speaking, heavy field excitation produces powerful torque at low speed, while a weak field produces low torque at high speed; but these effects are modified by the amount and disposition of iron in the magnetic circuit, and exact rules cannot be defined in simple terms. Speed regulation can also be effected by varying the proportionate flow of current in the two windings, but may be more difficult to carry out in practice. Shunt-wound motors are often regulated by a rheostat in series with the field winding only, so as to enable the field to be weakened without altering armature current, and speed thereby increased. This principle cannot be applied to series-wound motors, as any resistance in the circuit must necessarily affect both windings; but if the field winding is fed from a potential-dividing rheostat in series with the armature, field current can be regulated while still retaining series characteristics. Large motors, particularly those of the traction type, are regulated by a complex system of series-parallel switching applied to sections of the windings. The control of small alternating current motors presents special problems, owing to inductance and impedance effects in the windings.

No. 8021.—Lathe Difficulties.
P. R. (Worksop)

Q.—As a rather recent subscriber to your MODEL ENGINEER and *Model Car News*, I should appreciate your practical advice on turning problems. I have a 3-in. lathe, which is in fairly good condition, no wear being present on the slides and mandrel.

At present my only method of grinding tools is by comparison with the various standard works on the matter. I notice that after regrinding tools once or twice, I suffer from tool chatter.

Is it worth my while to fit this lathe up with Universal slide-rest, dieheads, etc., or should I look out for something bigger? Present equipment consists of S.C. and independent chuck, drill chuck and an assortment of tools. I suspect the mandrel of being bent (about - 0.001 in. at the faceplate edge). Is it worth bothering about, or is the lathe worth a new mandrel?

R.—It should be possible to do quite good work on the type of lathe referred to, and many users of such lathes have fitted them with additional equipment and accessories with success, but it should always be remembered that with these simple, light lathes, the operator is more dependent upon his own skill and resources than is the case with larger and heavier machines. If, however, there is the least suspicion that the mandrel is bent, so as to throw chucks, centres and faceplates out of truth, this is a serious fault, which must be rectified before reliable accuracy of work can be assured. In view of the present scarcity of lathes, we should certainly say that a new mandrel would be worth while. Tool-grinding and setting is most important, and the only way to ensure success is to adhere closely to the rake and clearance angles specified for various materials.

We strongly recommend "The Beginner's Guide to the Lathe" and "Practical Lessons in Metal Turning," two of our handbooks.